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Analysis of Strength Properties of Sandy Soil stabilized with Sugarcane Bagasse Ash

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***Abstract*— In the fast developing world, a better way to overcome the scarcity of resources is to use them more efficiently. The land with well characterized soil is such a limited resource in construction and transportation fields. Nowadays, soil stabilization is accepted as a common practice to improve the engineering properties of locally available soil to meet the strength requirements for different projects. A number of studies have been done on application of waste materials for soil stabilization since this practice can be cost effective as well as it can solve the problem of waste disposal, which is a threat to environment. Sugar-cane bagasse ash is one of the major agricultural waste in north India. Some recent studies proved the applicability of Bagasse ash as a cementing material both in concrete and for stabilizing soil. The presence of silica, calcium, and alumina brings pozzolanic characteristics to Bagasse ash, which when hydrated can bind the soil particles together. A number of research works have been conducted on improvement of expansive soil using bagasse ash, while, little results are available on effectiveness of Bagasse ash in improving properties of sandy soil. In the present study, the influence of Bagasse ash on engineering properties of sandy soil found in Chandigarh University campus (Mohali District, Punjab), is experimentally analyzed by conducting Light compaction test and CBR test.**

Keywords*— Soil Stabilization, Sandy Soil, CBR, Standard Proctor Test

I. INTRODUCTION

A. *Soil stabilization*

Soil is the ultimate foundation which takes all the loads exerted by all the living and non-living things on earth. At some places, naturally occurring soil itself will be capable of bearing all the loads acting on it, while at some other places soil is not strong enough to carry all the loads safely. There comes the importance of soil stabilization. Soil stabilization is a process of improving soil properties by blending and mixing additional materials with soil. This can be carried out by adding cementing materials such as cement, lime, bitumen/asphalt etc. or chemicals such as calcium chloride, sodium chloride etc.to the soil. Soil stabilization plays an important role in highway engineering as it helps to provide a subgrade of sufficient strength.

B. *Bagasse ash as a stabilizing material*

Sugar refining industry produces a huge amount of Bagasse ash as waste product. Disposal of bagasse ash is posing a big environmental issue and it is necessary to go for urgent remedial measures. Bagasse ash is rich in amorphous silica, calcium, alumina etc. which induces pozzolanic properties so that bagasse ash can act as a cementing material. It has already been used as a concreting material and also as an admixture. Recent studies show that it can be used as a binding material for stabilizing soil just like fly ash. Fly ash though is better than bagasse ash, but what gives priority to bagasse is that it is free of cost whereas fly ash is costly.

II. LITERATURE REVIEW

M. Chittaranjan et al. (2011) studied the use of Agricultural wastes as soil stabilizers. In this study bagasse ash, rice husk ash and groundnut shell ash were used to stabilize the soil. These admixtures were added separately at different percentages and CBR test was carried out to find out improvement in strength of mix. An increase in CBR value was observed with the increase in percentage of waste.

Ken C. Onyelowe (2012) studied compaction characteristics and CBR value of lateritic soil stabilized with both cement and Bagasse ash. The studies were conducted at two fixed cement contents such as 4% and 6% of weight of soil, and varying ash contents. The increased strength properties showed capability of bagasse ash in strengthening the soil properties.

K. S. Gandhi (2012) conducted different tests on expansive clayey soil with varying percentage of bagasse ash to check the effect on swelling pressure and on basic properties. He observed a rapid strength gain as well as a decrease in swell potential of Bagasse ash stabilized subgrade soil.

Kiran R. G. and Kiran L (2013) analyzed Strength Characteristics of Black Cotton Soil stabilized using Bagasse Ash along with cement and lime as additives. Compaction test, CBR test and UCS tests were conducted on pure soil and soil samples with different percentages of bagasse ash and other additives. Density of soil was not found to be changed considerably, while, strength properties showed significant improvement.

Amit S. Kharade et al. (2014) conducted laboratory experiments such as CBR test and UCS test on black cotton soil with partial replacement by Bagasse Ash at different percentages. An optimum value of Bagasse ash content was figured out at which the soil-ash mix exhibited the maximum strength properties.

Prakash Chavan and Dr.M.S.Nagakumar (2014) evaluated the plasticity index, specific gravity, compaction characteristics, CBR value and unconfined compressive strength (UCS) of Bagasse Ash stabilized black-cotton soil. The Plasticity index showed a decreasing trend with increase is ash content, whereas strength properties were observed to

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be increased to peak values at optimum ash content and decreased on further addition of ash.

III. SCOPE OF STUDY

Even though a number of studies have been carried out on use of bagasse ash as a soil stabilization material, most of them were done for expansive clayey soil. In the present study, influence of bagasse ash on engineering properties of sandy soil is studied experimentally.

IV . EXPERIMENTAL WORK

Soil selection and classification

Soil required to conduct the experimental works was collected from Chandigarh University campus, Gharuan, located in Mohali district of Punjab state. Sieve analysis was conducted to determine the particle size distribution of the soil (Fig.1) as per IS 2720 (Part 4) – 1985 and specific gravity was determined using Pycnometer according to IS 2386(Part III)-1963. The primary test results are listed out in table 1.

Bagasse ash

Bagasse ash was collected from The Morinda Co-op. Sugar Mills Limited (Rupnagar District, Punjab) and processed it to get about 10kgs of dry bagasse ash. Chemical properties of bagasse ash are shown in table 2 (sited from K. S. Gandhi, 2012)

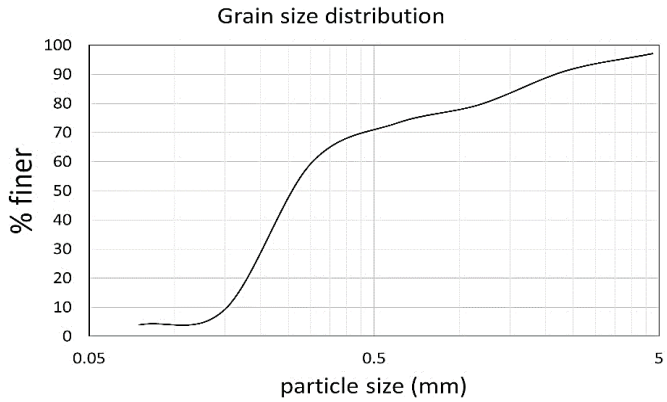

Fig.1: Grain size distribution of soil

Specific gravity	2.64
Fine fraction	3.97%
Coefficient of uniformity (Cu)	1.28
Coefficient of curvature (Cc)	1.01
IS classification	Poorly graded Sand (SP)

Table 1: Properties of soil used for experiments

Description	Abbreviation	Percentage (%)
Silica	Sio2	60.26
Iron	Fe2o3	5.03
Calcium	Cao	8.35
Magnesium	Mgo	0.40
Sodium	Na20	1.33
Potassium	K2o	5.57
Chloride	Cl	0.20
Sulphate	So4	1.30
Phosphorus	P2o5	2.69
Loss of Ignition	-	3.39
Alumina	Al2o3	10.73
Titanium	Tio2	0.13
Manganese	Mn	0.078
Wax Content	-	Nil

Table 2: Chemical properties of bagasse ash (K. S. Gandhi, 2012)

Tests conducted

A.Light Compaction Test

Light compaction test (Standard Proctor Test) was conducted on the pure soil to find out maximum dry density($\gamma_{d,max}$)and optimum moisture content (*OMC*) according to specifications given by IS: 2720 (Part VII)-1980. Same test was repeated by replacing some percentage of soil by Bagasse ash such as 5%, 7% and 10% of total weight.

B.CBR test

California Bearing Ratio of the soil was determined as specified in IS 2720 (Part XVI) – 1987**.** Same test was repeated by replacing some percentage of soil by Bagasse ash such as 5%, 7% and 10% of total weight.

RESULTS OBTAINED

Compaction curves were plotted for samples with different percentage of bagasse ash which is illustrated in Fig.2. Variation of maximum dry density with different percentages of bagasse ash is shown graphically in Fig.3. Variation of OMC with different percentages of bagasse ash is shown graphically in Fig.4. Fig.5 shows the variation of CBR value with different percentages of bagasse ash.

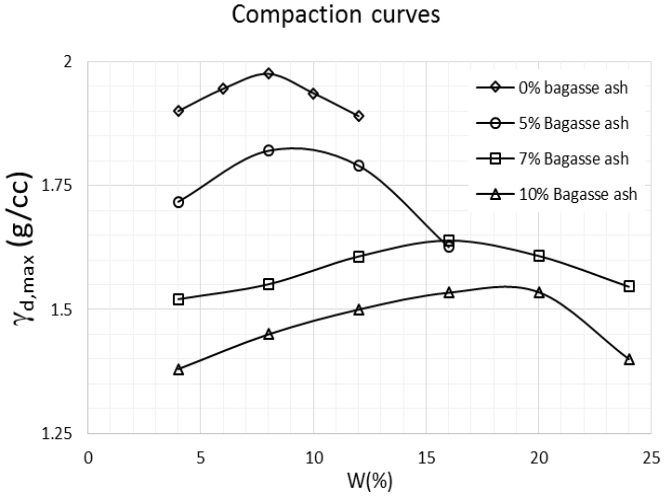

Fig. 2: Compaction curves

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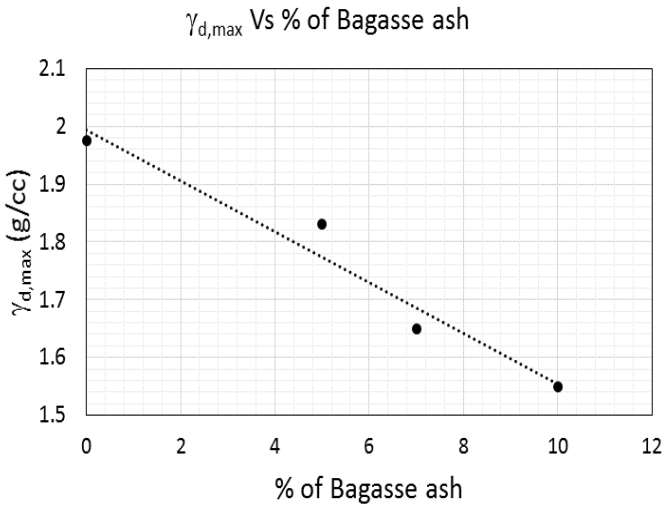

Fig. 3: Variation of maximum dry density with % of bagasse ash

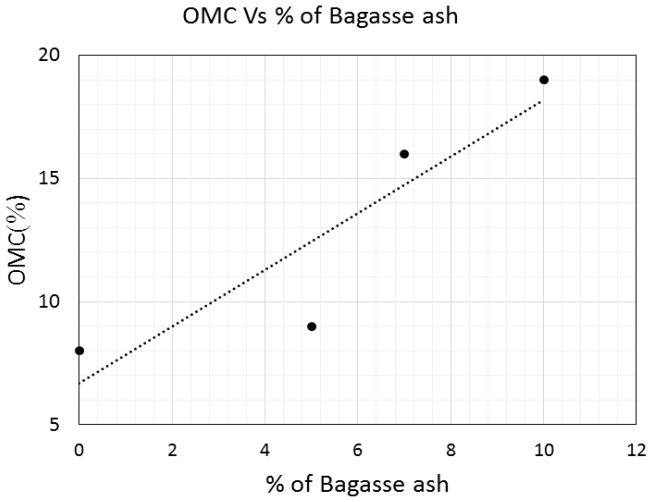

Fig. 4: Variation of optimum moisture content with % of bagasse ash

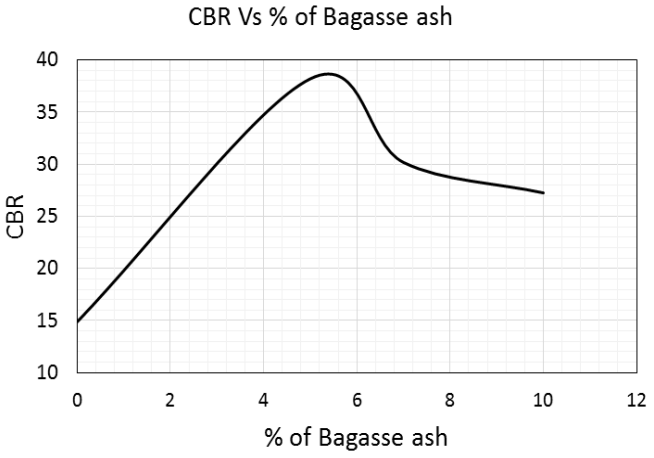

Fig. 5: Variation of CBR value with % of bagasse ash

V. CONCLUSIONS

Influence of sugarcane bagasse ash on engineering properties like maximum dry density, OMC and CBR value of sandy soil was studied experimentally. It was observed that optimum moisture content increases with increase in % Bagasse ash due to the increase in specific surface, whereas, maximum dry density of soil decreases with increase in % of Bagasse ash. This is due to the basic fact that the soil-bagasse ash mix have different specific gravity than the original soil. Also the presence of fine particles (bagasse ash) increases the capillary force developed due to addition of water. This capillary force resists the rearrangement of particles against the external compactive energy.

The experimental results shows considerable improvement in CBR value by replacing 6-7% soil by Bagasse ash. It was observed that further increase in ash content reduce the bearing capacity of soil. The reason for strength improvement is that the hydration of the bagasse ash forms the normal hydration products that bind soil particles together. As the bagasse ash content is increased it reaches an optimum value at which the ash content is sufficient to make proper bonding between all the soil particles. If ash content is increased further, it will not contribute to the strength gain. Instead, it reduces the soil strength. From the present study, it was concluded that for improving the strength of sandy soil present in local region of Chandigarh University, the optimum value of bagasse ash content is 6-7% of total dry weight of the mix.

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