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Stabilization of soil using bagasse ash and fly ash

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Abstract- **Enhancement of load carrying capacity and shear strength of soil has been improved by soil stabilization. The largely used soil stabilizing agent is fly ash, the waste from coal fired power plant, which is produced over 100 trillion each year creating thoughtful dumping as well as ecological complications in India. The wastes of industries and agriculture adversely affect the environment as high land area will be required for their disposal and when they disintegrate, results in the production of harmful gases causing, soil contamination, land fill space and many other hazardous effects. Soil stabilization is a process that improves the engineering properties of soil such as strength, volume stability and durability. Sugar Cane Bagasse Ash (S.C.B.A.), a waste material from the sugar industry is used as a stabilizer in modifying the properties of the soil. Bagasse is a fibrous residue of sugarcane stalks that remains after extraction of sugar and when incinerated gives the ash. The chemical analysis on bagasse ash was found to contain mainly silica, and potassium, iron, calcium, aluminum, magnesium as minor components and exhibit pozzolanic properties.**

Index Terms- **Soil Stabilization, Sugar cane bagasse ash, fly ash .**

INTRODUCTION

Importance of ground improvement technique is increasing now a day. At some construction sites, the soil properties may not meet to the necessitate provision; hence it is required to improve the characteristics of soil. Soil stabilization may be grouped under two main type's i.e. Modification of soil without adding any stabilizing agent and ii. Improving the properties by means of admixtures. Fly ash as additive have great influence as it is industrial by product, thus inexpensive to cement or lime e and increases the strength of soil as pointed out by Bose3. Fly ash admixed with organic soil and its outcome was the dry density of admixed so reduced to 15% to 20% due to low specific gravity of fly ash given by Prabhakar4.

In sugar industry sugar cane straw is produced as major by product during manufacturing off sugar. Bagasse ash is an agricultural by product of sugar cane bagasse incineration to generate electricity and its improper deposit poses a serious environmental problem.

MATERIALS AND METHODS

A. Soil

For the present research work soil was collected from Dholeshwar village, Gandhinagar in Gujarat from a depth of 20 cm from the Natural Ground Level. For this research work soil passing through 425 μ IS sieve was used.

TABLE 1: INDEX PROPERTY OF SOIL

Properties	Soil
Type of soil	SM
Coefficient of uniformity	3.23
Coefficient of curvature	0.886
Specific gravity	2.321
Plastic limit	28.169%
Plasticity index	5.331

B. Bagasse ash

Bagasse is the matted cellulose fiber residue from sugarcane that has been processed in a sugar mill, used as a source of cellulose for some paper products. The major sugar producing States in India are Maharashtra, Uttar Pradesh, Tamil Nadu, Karnataka, Gujarat and Andhra Pradesh considering total sugar production. Bagasse is a by-product from sugar industries which is burnt to generate power required for different activities in the factory. The burning of bagasse leaves bagasse ash as a waste, which has a pozzolanic property that would potentially be used as a cement replacement material. The sugarcane bagasse consists of approximately 50% of cellulose, 25% of hemicellulose and 25% of lignin. Each ton of sugarcane generates approximately 26% of bagasse and 0.62% of residual ash.

TABLE 2: Chemical composition of bagasse ash

Chemical Composition	Mass(%)
Silica (sio_2)	62.43
Aluminum oxide (Al_2O_3)	4.38
Ferric oxide (Fe_2O_3)	6.98
Calcium oxide (CaO)	11.8
Magnesium oxide (Mgo)	2.51
Sulphur trioxide (So_3)	1.48
Potassium oxide (K_2O)	3.53
Loss of ignition	4.73

TABLE 3: Physical Properties of Bagasse ash

Color	Grey
Density g/cm3	2.52
Surface area (cm2/g)	5140
Particle size	28.9

C. FLY ASH

In recent time, the importance and use of fly ash has grown so much that it has almost become a common ingredient in concrete and soil, particularly in making high strength and high-performance concrete and soil.

There are two ways that the fly ash can be used: one way is to integrand certain percentage of fly ash with cement clinker at the factory to produce Portland pozzolona cement (PPC) and the second way is to use the fly ash as an admixture at the time of mixing the concrete at the site of work. But the main problem is that the fly ash produced in the 75 thermal power plants in India is not of the similar characteristics. The quality of fly ash should be of the standard of *IS: 3812-1981*. For better utilization of fly ash, it becomes important to know the hydration reactions, pozzolanic activity evaluation, effect of fly ash on fresh and hardened concrete, durability etc.

Properties	Value
Type	Class C
Specific Gravity	2.08
Coefficient of uniformity	3.14
Coefficient of curvature	2.344
Liquid limit & Plastic limit	Non-plastic
Silica	60.85%
Alumina	29.14%
Iron Oxide	3.01%
Titanium Oxide	0.68%
Lime	1.88%
Magnesia	0.35%
Potash	0.53%
Soda	0.48%

Table 4: Properties of fly ash

Compaction test

An important characteristic of soils is that compaction improves their shear strength and compressibility properties. Such characteristics follow the principles stated by R.R. Proctor in 1933. The most recognizable development of his theory was a test now known as the “Standard Proctor,” the water content at which the maximum density is obtained from the relationship provided by the test. About 2.5 kg of air-dried, pulverized soil passing 4.75mm sieve is taken. Water is added to the soil to bring its water contend to about 4% if the soil is course-grained and to about 8% if it is fine - grained. The soil is mixed thoroughly. The mould is filled in a three layer by soil mass. The soil is compacted by 25 blows of the rammer (2.5kg), with free fall 300mm. weighed the mould and the sample and recorded on data sheet. Small quantity of soil sample was taken for determining moisture content. The experiment was repeated by increasing the moisture content by 4%.

Box shear test

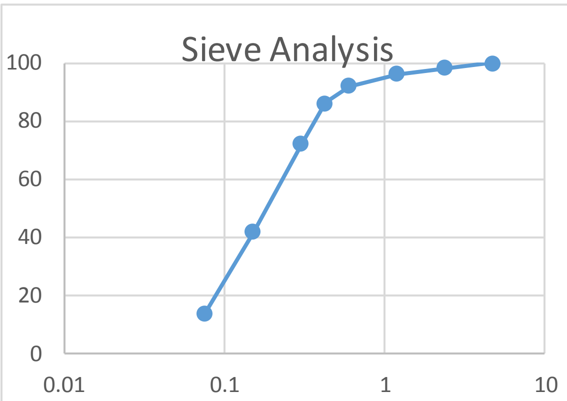
The test is performed on three or four specimens from a relatively undisturbed soil sample. A specimen is placed in a shear box which has two stacked rings to hold the sample; the contact between the two rings is at approximately the mid-height of the sample. A confining stress is applied vertically to the specimen, and the upper ring is pulled laterally until the sample fails, or through a specified strain. The load applied and the strain induced is recorded at frequent intervals to determine a stress–strain curve for each confining stress. Several specimens are tested at varying confining stresses to determine the shear strength parameters, the soil cohesion (c) and the angle of internal friction, commonly known as friction angle. The results of the tests on each specimen are plotted on a graph with the peak (or residual) stress on the y-axis and the confining stress on the x-axis. The y-intercept of the curve which fits the test results is the cohesion, and the slope of the line or curve is the friction angle.

Direct shear tests can be performed under several conditions. The sample is normally saturated before the test is run, but can be run at the in-situ moisture content. The rate of strain can be varied to create a test of undrained or drained conditions, depending whether the strain is applied slowly enough for water in the sample to prevent pore-water pressure buildup. Direct shear test machine is required to perform the test. The test using the direct shear machine determinates the consolidated drained shear strength of a soil material in direct shear.

Result and Discussion

SIEVE ANALYSIS

The particle size distribution curve of this soil determined based on sieved through 4.75mm sieve.



SPECIFIC GRAVITY

The specific gravity of Silty sands are determined in a laboratory as per IS 2720 part-II by using a density bottle.

TABLE 5: SPECIFIC GRAVITY

Sr no.	Mass of Empty Density Bottle (M1) gm	Mass of Density Bottle + Dry Soil (M2) gm	Mass of Density Bottle+ Dry Soil + Distilled Water(M3)gm	Mass of Density Bottle + Distilled Water (M4) gm	G = M2 – M1 (M4 – M1) – (M3- M2)
1	31.45	47.40	91.90	81.85	2.23
2	32.05	42.40	88.45	82.05	2.29
3	35.45	45.65	92.30	86.20	2.32
4	30.65	41	109	102.5	2.38
5	32.25	42.55	110.30	103.85	2.30
6	30.70	40.85	108.65	102.50	2.43

❖ From the laboratory work Specific gravity is found out for soil is 2.321

ATTEREBERG LIMITS

1) Liquid limit

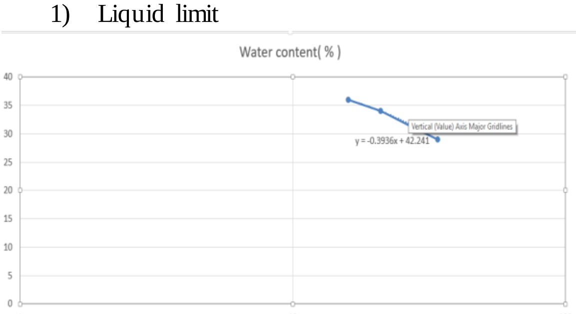


CHART 1: LIQUID LIMIT

Liquid limit of Silty sand is 32.5%

2) Plastic limit

TABLE 6: PLASTIC LIMIT

Sr. No.	Sample	Mass of wet Soil (M1) in Grams	Mass of oven dry soil (M2) in grams	Mass of water in grams	Water Content (%)
1	Soil	50	11	39	28.169

Plasticity Index is given by the formula, PI = LL – PL. For BCS, Similarly PI for other sample was computed. The table below shows the PI for all the Samples.

TABLE 7: PLASTIC INDEX

Sr. No.	Sample	LL	PL	PI
1	Soil	32.6	28.169	4.431

STANDARD PROCTER TEST:

Mould Diameter 0.1 m, Height 0.127, Volume 0.001 m^3, Weight 3.663 kg

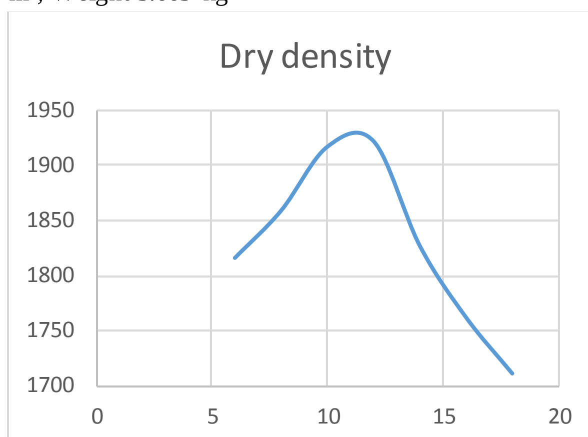


CHART 2: SOIL

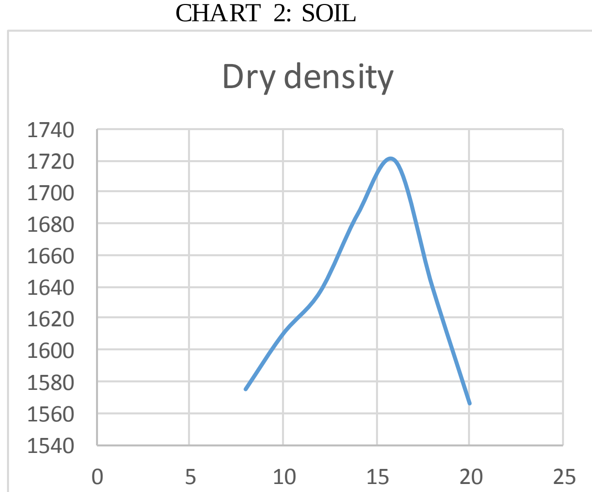


CHART 3: SOIL+ 5% B.A

Mould Diameter 0.1 m, Height 0.127, Volume 0.001 m^3, Weight 3.663 kg

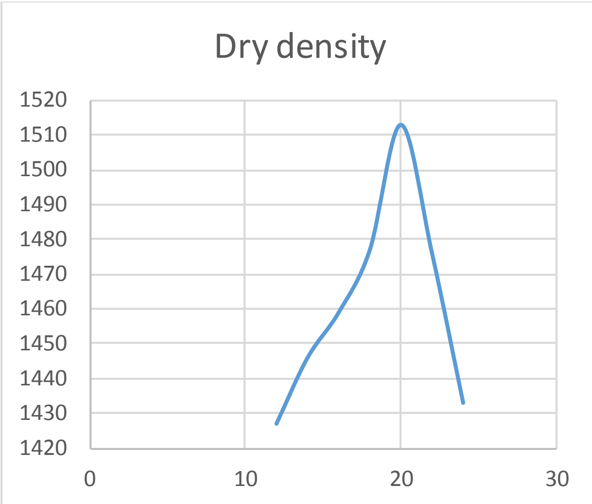


CHART 4: SOIL + 10% B.A

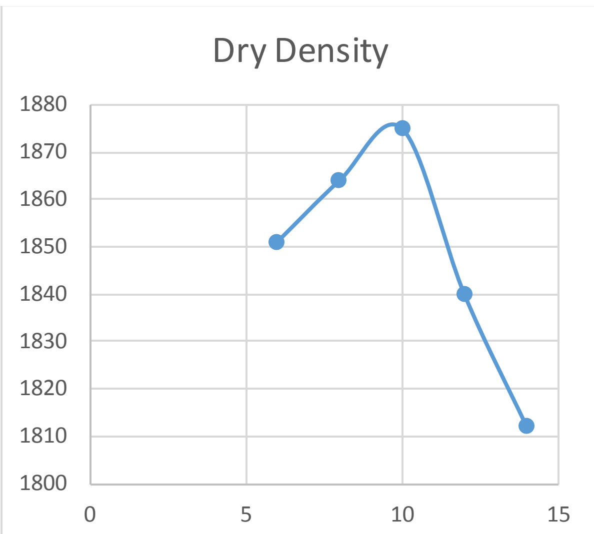


CHART 5: SOIL + 5% FLY ASH

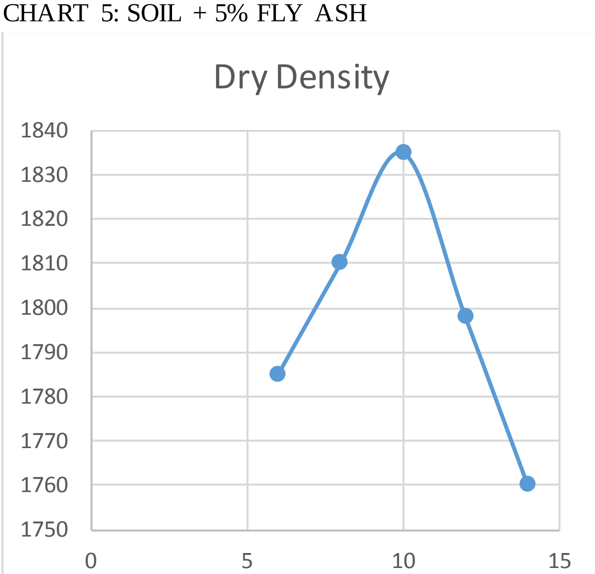


CHART 6: SOIL + 10% FLY ASH

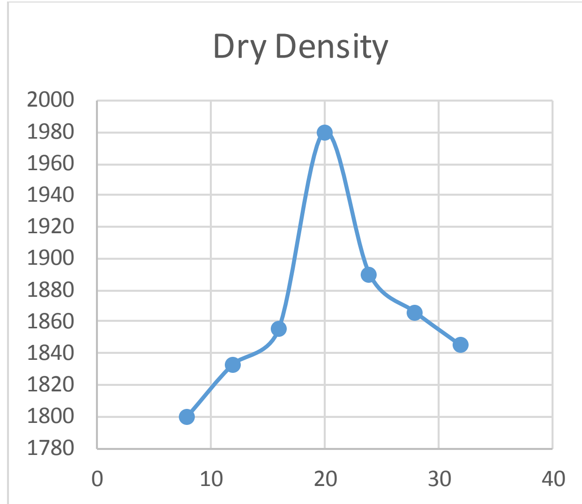


CHART 7: SOIL + 5% FLY ASH + 2.5% B.A

BOX SHEAR:

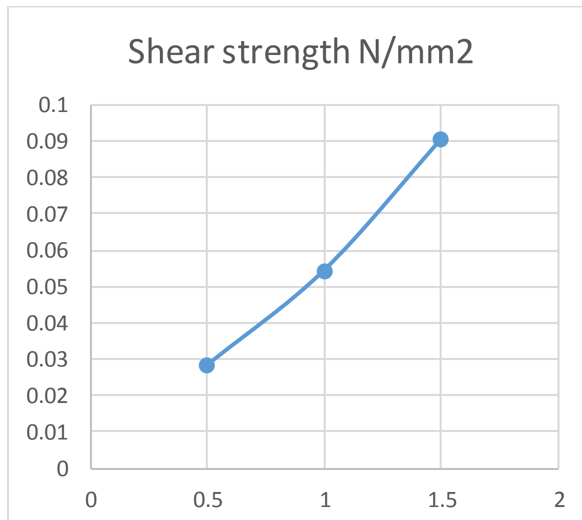


CHART 8: SOIL

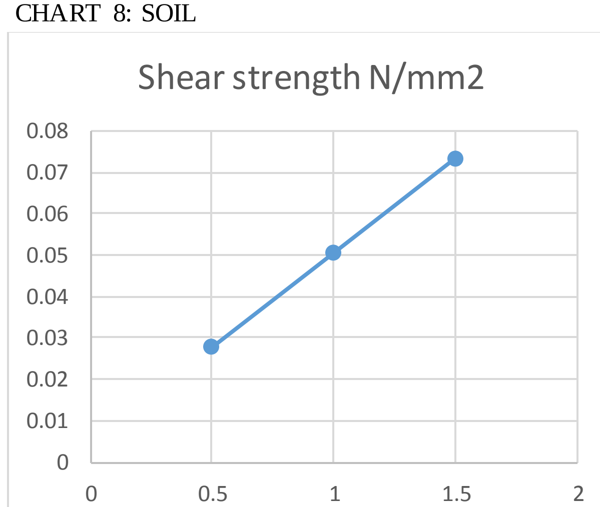


CHART 9: SOIL + 5% B.A

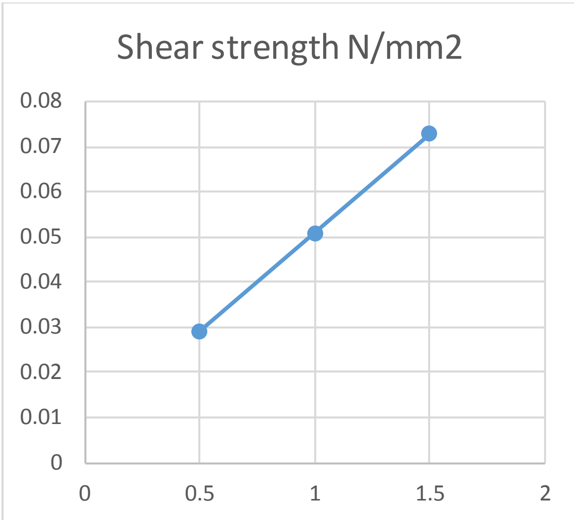


CHART 10: SOIL + 10% B.A

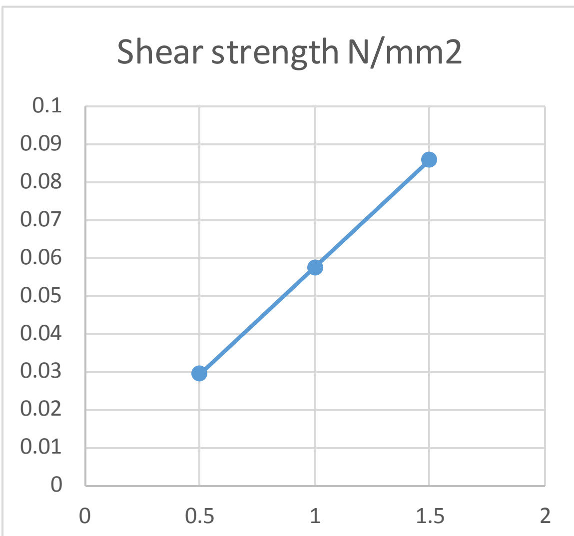


CHART 11: SOIL + 5% FLY ASH

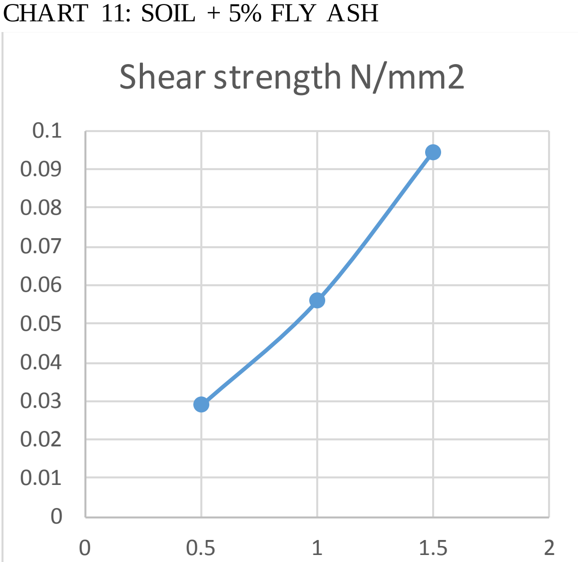


CHART 12: SOIL + 10% FLY ASH

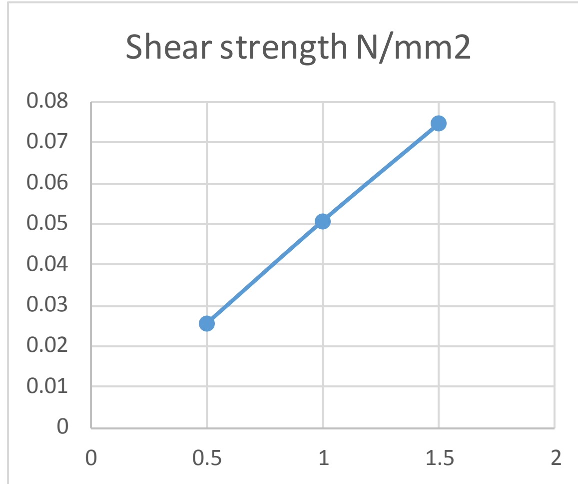


CHART 13: SOIL + 2.5 B.A + 5% FLY ASH

CONCLUSIONS

For Soil with partially addition of 5% Fly ash the shear strength of soil is increase for Normal stress of 0.5 & 1.0 kg/cm^2, as normal stress increase the Shear strength of soil is decrease. For Soil with partially addition of 10% Fly ash the shear strength of soil is increase for Normal stress of 0.5, 1.0 & 1.5 kg/cm^2. For Soil with partially addition of 10% Fly ash and 5% Bagasse ash the shear strength of soil is increase for Normal stress of 0.5, 1.0 & 1.5 kg/cm^2.

Soil can be used with addition of 5% Bagasse ash as its dry density is increase. Soil cannot used with addition of Fly ash as its dry density is decrees with 5% and 10% of Fly ash.

Advantageously the soil can be used with partially addition of 2.5% Bagasse ash and 2.5 % Fly ash.

So, Recycling/utilization of fly ash and sugar cane bagasse ash has the advantage of using industrial waste by-products without harmfully affecting the environment or probable land use with in addition fly ash and sugarcane bagasse ash proved to be effective admixtures for enhancing the engineering behavior considerably.

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