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STABILIZATION OF BLACK COTTON SOIL USING BAGASSE ASH.

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Abstract: - Over the last decade problems related to disposal of industrial waste has become a serious concern. To overcome this problem of industrial waste generation it is imperative to use this generated waste to some other basic material like admixture for stabilization of soil, stabilization of soil is an technique to improve the properties of soil such as bearing capacity, strength, settlement ,density etc. Montomorillonite mineral which is present in large amount in black cotton soil and results in cracking of soil. it becomes hard on drying and reduce strength and shrink when comes in contact with water. Use of industrial waste like sugarcane bagasse ash, can be used as an admixture for improving the properties of black cotton soil thus waste products of the industry can be used effectively. Hence this study focuses on productive use of industrial waste like sugarcane bagasse ash, and examine to see weather addition of such waste will result in soil enhancements or not. Waste in proportions of 4%, 8%, 12%, 16% will be respectively replaced with the black cotton soil and stabilization of soil will be done and conclusion will be done on the basis of result obtained.

Keywords—Black cotton soil, Industrial Waste, Sugarcane bagasse ash, Soil Stabilization

I. INTRODUCTION

Black cotton soil is one of major soil deposit of India. These soils contain essential clay minerals as montmorillonite due to which it cause high rate of shrinkage and swelling properties when exposed to change in moisture content it expand and become sticky during rainy season and contract becomes stiff on dry season. These soils cover an extensive area of 3 lakh sq.km which is mainly spread over Maharashtra, Saurashtra, Madhya Pradesh, Chhattisgarh and extent in south east. The technique which is used to improve the properties of soil, increase its strength and make it suitable for used as foundation material for construction of various engineering structure is known as soil stabilization. In case of black cotton soil refers to improve its properties such as bearing capacity, shear strength, swelling, etc. Black cotton soil mainly consists of montmorillonite mineral which is made of water bond which cause high rate of swelling when it comes in contact with water and shrinks when drying. Stabilization of black cotton soil is necessary to improve this property and making it more stable specially when the soil to be used as foundation material which is the most important part of any structure. Various methods are available to improve the properties of soil Stabilization of soil can be achieved either by mechanical means such as vibrating, compacting or chemical or admixtures by changing its properties by replacing some proportion of soil with admixtures. with the advancement in construction techniques various methods and techniques are available to improve the properties of black cotton soil but it requires more cost which plays an important role in all construction project. To enhance the properties of black cotton soil and make it economical the attempt has been made in this paper by replacing the suitable amount of black cotton soil with sugarcane bagasse ash. Sugarcane bagasse ash is a residue left of sugarcane bagasse after extraction of sugar from it, sugars bagasse is rich in silica content which help in improving cohesive properties and reducing swelling by creating bonding between soil particles. In this paper black cotton soil is replaced by sugarcane bagasse ash in proportion of 4%, 8%, 12%, 16% and 20% and laboratory testing is carried out for each mix and optimum amount of replacement of sugarcane baggage is obtained

II. LITERATURE REVIEW

Many of the researchers have worked in stabilization of different types of soil using different methods which are economical and feasible. Stabilization of soil is prime objective when it is used construction projects, the most common application being in the construction of roads and air-field pavements, main objective of stabilization is to reduce the cost

of overall construction by using locally available material. Method of stabilization may be grouped under two main types:
a) Modification or improvement of soil property of existing soil without any admixture,
b) Modification of properties with the help of admixtures.
Compaction and drainage are examples of the first type. Mechanical stabilization, stabilization with cement, lime, bitumen and chemicals, etc are examples of second type. There are many attempts made in stabilizing soils with the use of wastes and additives, here are some of the research works carried on stabilizing soil with use of wastes.

N. Vijay Kumar, S.S. Asadi, A.V.S. Prasad [1] Through his work they studied the effect of admixture such as bitumen emulsion, egg shell powder, coconut shell ash on the strength of laterite soil for different dosage of admixture (5%, 10%, 15%, 20%) and performed CBR test and direct shear test for virgin soil and different dosage of admixture. through his work they concluded that there is increase in strength of laterite soil with increase in admixture content upto 10% and further addition of admixture shows considerably decrease in strength of laterite soil.

Krichphon Singh, V.K. Arora [2] through his work they studied the effect of industrial waste (Marble dust), in improving unconfined strength of soil by adding different dosage of marble dust in the soil (5%,10%,15%,20%). Through his work they concluded that with increase in percentage of marble dust content the dry density decreases and optimum moisture content increases. the increase in unconfined shear strength was found 1.032 form .60 at the optimum value of marble dust dosage of 15%

P.A. Sivasubramani, C. Arya, R.Karunya [3] through his work they demonstrated the impact of Bagasse Ash (BA) and Egg Shell Powder (ESP) to stabilize soft and expansive soil. Specific gravity, wet sieve analysis, Liquid Limit (WL) and Plastic Limit (WP) tests for the physical properties of the virgin soil. The soil has been classified as Clay of Medium Compressibility (CI). BA and ESP are to be replaced to stabilize the soil in the proportions from 5% to 25% by weight of soil and addition of 3% of ESP then CBR tests are conducted. The final result were such as 25% of BA and 3 % addition of ESP stabilize the soil to clay with low compressibility (CL) and produces the optimum result.

Niken Silmi Surjandari, Noegroho Djarwanti [4] through his work they evaluate the enhancement of the engineering properties of expansive soil using bagasse ash. The test carried out on soil where physical and strength performance tests, namely the plasticity index, standard Proctor compaction, and percentage swelling in the proportion of Bagasse Ash (0, 5, 10, 15, and 20%). For chemical composition of bagasse ash test such as X-ray diffraction, X-ray fluorescence were carried out. As a result of this test BA reduces the plasticity index and the percentage swelling and increases the maximum dry density.

Karan Gupta, Wajid ali Butt [5] through his work they conducted test of clayey soil of J & k with saw dust ash as a admixture, the saw dust ash was replaced by clayey soil in the proportion 4%, 8%,12% and 16%. Through his work they observed that with increase in saw dust ash content the maximum dry density values decreases gradually and optimum moisture content value increases. liquid limit, plastic limit, specific gravity, unconfined compressive strength of the soil were improved by adding saw dust ash, The CBR value increased by 103.11% and unconfined compressive strength increases 26.35% at 4% saw dust ash.

Pallavi, Pradeep Tiwari, Dr. P.D. Poorey [6] through his work an attempt has been made to utilize industrial wastes such as fly ash and Nylon fibres as stabilizing agents. The effect of admixture on engineering properties of soil such as Liquid Limit, Plastic Limit, Plasticity Index, Dry density, OMC, CBR (Soaked) of clayey soil had been studied. Study the effect of varying percentage of fly ash (10%, 20%, 30%, 40%) and varying percentage of Nylon Fiber (0.25, 0.50, 0.75, 1, 1.25, 1.50) on properties of Soil sample and then combined admixture are mixed with black cotton soil by varying percentage and optimum quantity of fly ash and optimum quantity of Nylon fibre at various aspect ratio on properties of Black Cotton Soil. Through above study they concluded the optimum percentage of flyash and optimum percentage of nylon fibre at different aspect ratio to find improvement in black cotton soil.

A. Venkatesh, Dr. G. Sreenivasa Reddy [7] through his work attempt has been made for Effective utilization of Waste Saw Dust Ash as stabilizer which could result in solution of land fill problems. Waste Saw Dust Ash is added to the soil in the proportion of 2%, 4%, and 6% in dry weight of the soil. Different test are carried out such as light compaction test and falling head permeability test were conducted for different percentages of Waste Saw Dust Ash. After the test they concluded that 5.4% of dry density was increased in addition of 2% of WSDA and then dry density was reduced gradually on increasing the percentage of Waste Saw Dust Ash. Permeability of soil was also reduced.

Ashok Kumar, Karthik.**[8]** Through their work, They examined the effect of fly ash on engineering properties of soil such as Free Swell Index (FSI). The fly ash was used in the proportion of 0, 5, 10, 15, 20% percent of its dry weight and it was found that the plasticity of soil decreases with increase in flyash content. Free Swell Index (FSI) was also reduced by about 50% after the addition of 20% of fly ash.

Kiran R.G., Kiran L [9] through his work they carried out the analysis of Strength Characteristics of Black Cotton Soil Using Bagasse Ash and Additives as Stabilizer. They mixed the black cotton soil with sugarcane bagasse ash in the proportion of 4%, 8%, 12% and laboratory experiment are carried out to find its bearing capacity and shear strength. After performing the test they concluded that with the increase in sugarcane bagasse ash content there was increase in the dry density and CBR of soil which is found optimum at 8% mix of cement . The density which is found to be 16.5 KN/m3 for the mix of 8% bagasse ash, Then CBR values which is found to be 5.43 for the mix of 4% bagasse ash and unconfined shear strength which is found to be 84.92 KN/m2 for the mix of 8% bagasse.

III. METHODOLOGY

A. *Collection Of material*

BLACK COTTON SOIL

The soil which is used for stabilization were collected from site Yeshwantnagar which is located at sangli, Maharashtra. Before performance of experiment soil was oven dried and sieved through 4.75mm sieve. after initial testing the soil is classified to be clayey soil having plasticity (CH). The physical and chemical properties of soil are shown in table no 1 and 2

TABLE 1
CHEMICAL PROPERTIES OF BLACK COTTON SOIL

Sr No.	Properties	Value
1	PH	8.2
2	EC	0.13 ms/cm
3	Organic Carbon	1.33%
4	Phosphorous	18.54 kg/ha
5	Potassium	7.77 g/ha

TABLE 2
PHYSICAL PROPERTIES OF BLACK COTTON SOIL

Sr No	Properties	Value
1	Specific Gravity	2.41
2	Colour	Dark Black
3	Liquid Limit (WL)	67.36%
4	Plasticity Limit (WP)	32.75%
5	Coefficient of Uniformity (CU)	5
6	Coefficient of Curvature (CC)	1.03
7	IS Classification	CH



Fig.1 Black cotton soil

Sugarcane Bagasse ash

Sugarcane bagasse ash is a byproduct of sugar factories which is found after burning sugarcane bagasse after the extraction of all sugar from it. This waste material are rich in silica content which is similar to cement properties thus helps in good adhesion and bonding between week soils. To stabilize the black cotton soil the sugarcane bagasse ash is

obtained from the sugar factory "Vasantdada patil SSK Ltd." This is located at Vithevadi, Maharashtra. The bagasse ash obtained was fine and dark and colour and its chemical composition is shown in table no. 3

TABLE 3
CHEMICAL PROPERTIES OF SUGARCANE BAGASSE ASH

Sr No	Description	Percentage %
1	Silica	65.28
2	Iron	3.09
3	Calcium	2.84
4	Magnesium	1.54
5	Sodium	0.24
6	Potassium	6.40
7	other	20.61



Figure 2 Sugarcane bagasse ash

B. ***Testing of Soil Specimen***

Basic laboratory test conducted on virgin black cotton soil to find it index properties such as IS Classication, Atterberg limit, Swelling characteristic, Bearing capacity, OMC and MDD. Then the stabilization of black cotton soil is carried out by mixing with sugarcane bagasse ash in different proportion (4%, 8%, 12%, 16%) and then optimum percentage of sugarcane bagasse is determined. To determine the strength or bearing capacity of soil test carried out on different percentage of sugarcane bagasse ash (Standard proctor test, California Bearing Ratio Test) .after getting the results of all this mixes the comparison of best suitable admixture and its proportion determined.

C. ***Testing Procedure***

California bearing Ratio Test: The objective of test is to find the ratio expressed in percentage of force per unit area required to penetrate a soil mass with circular plunger of 50mm diameter at the rate of constant rate to that required for corresponding penetration in a standard material. The ratio is usually determined at 2.5mm and 5 mm penetration. Here the CBR test is conducted for every mix as per IS 2720 (Part 16)

Standard Proctor Test: The standard proctor test is carried out to determine the Optimum Moisture Content (OMC) which results in Maximum Dry Density (MDD) so that it can be used for compaction in CBR test mould. Here SPT test is conducted for virgin black cotton soil and every mix of specimen with sugarcane bagasse ash as per IS 2720 Part (VII)

Free Swell Index: Free swell is the increase in volume of soil, without any external constraint when submerged in water. Here the Free Swell Index is conducted for every mix as per IS 2720 (Part XL)

Consistency Limit: The liquid and plastic limit of soils are both dependent on amount and type of clay in the soil and form the basis for the soil classification system for cohesive soil based on plasticity test, Here the liquid limit and plastic limit test conducted for virgin soil and every mix of soil replacement by bagasse ash as per IS 2720 (Part 5)

IV. RESULT AND DISCUSSION

Compaction characteristics

The variation in maximum dry density and optimum moisture content with bagasse ash content % is shown in below Fig 5 to 9 respectively. However the optimum moisture content decreases with the increase in bagasse ash content and there is negligible variation in the dry density of the soil with the variation of bagasse ash percentage



Fig.3 Soil Mixed with Bagasse Ash



Fig.4 Compacted Soil

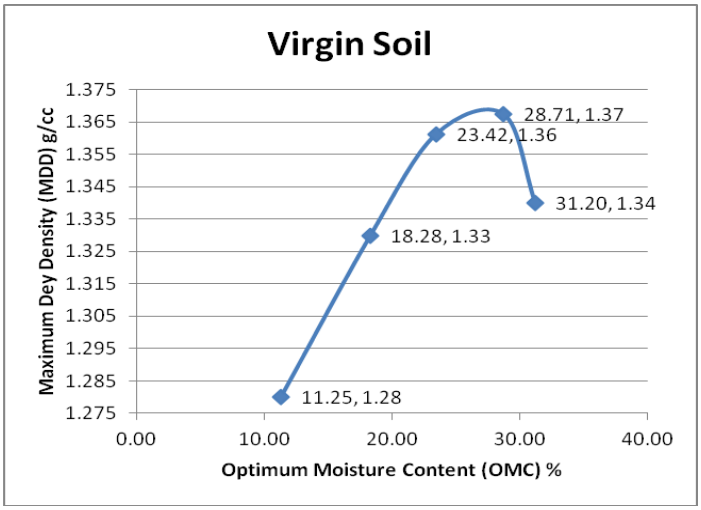


Fig.5 OMC vs MDD Curve for Virgin Soil

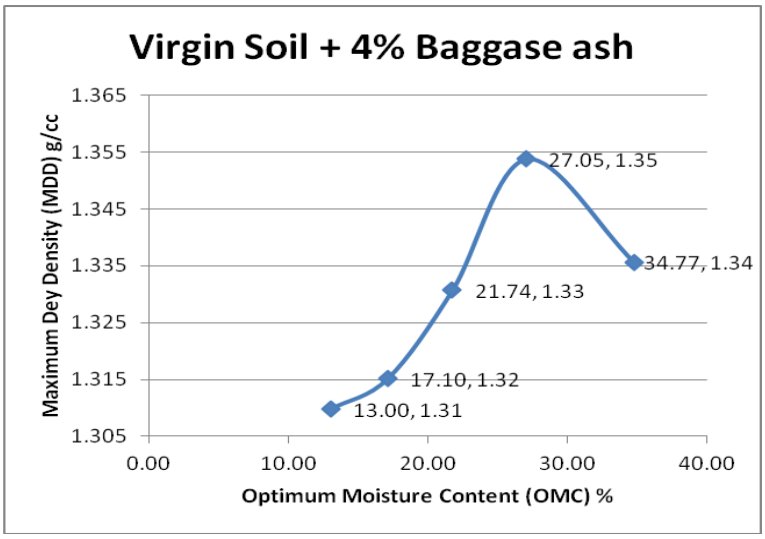


Fig.6 OMC vs MDD Curve For Soil replaced by 4% BA

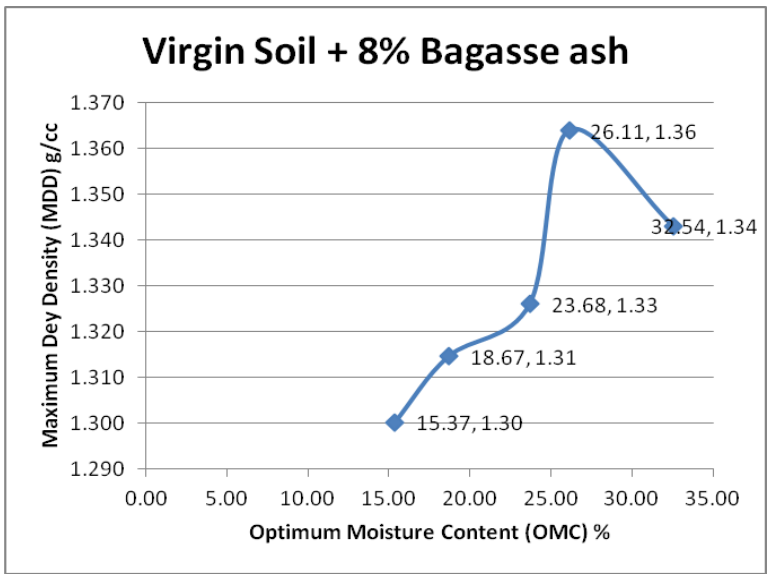


Fig.7 OMC vs MDD Curve For Soil replaced by 8% BA

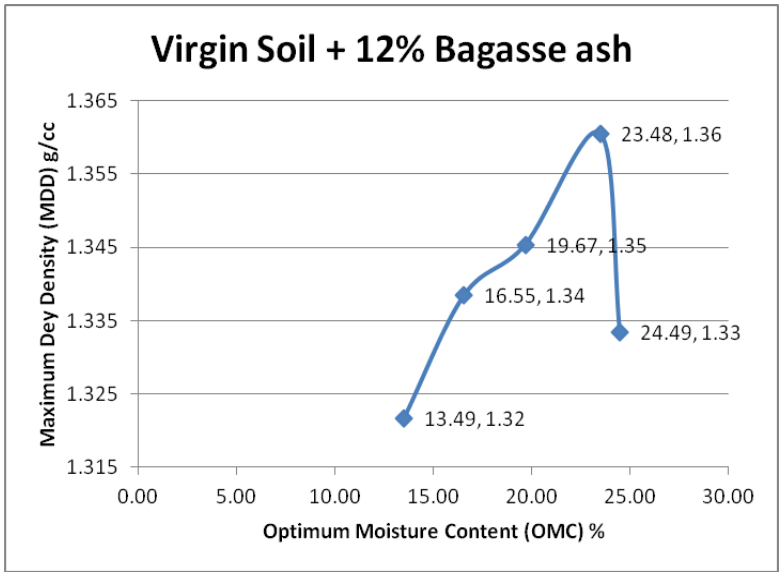


Fig.8 OMC vs MDD Curve For Soil replaced by 12% BA

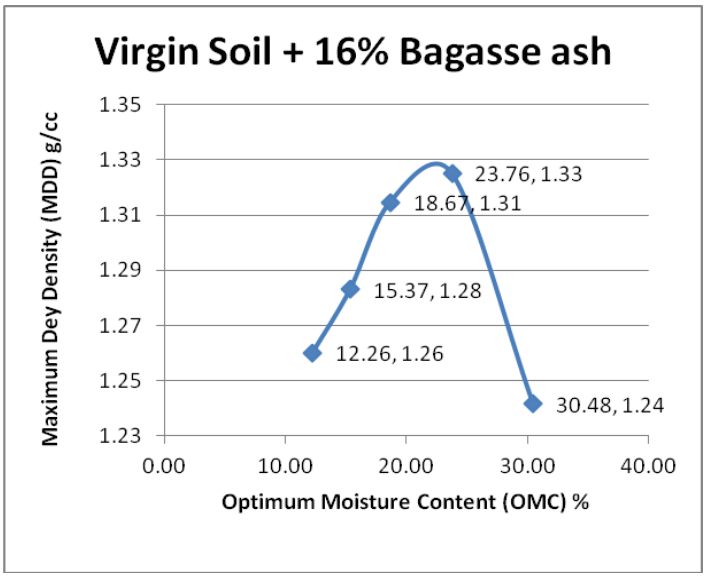


Fig.9 OMC vs MDD Curve For Soil replaced by 16% BA

California Bearing Ratio

California bearing ratio test is conducted on virgin soil and for every mix of soil with bagasse ash. With increase in bagasse ash percentage the CBR value of soil found to be increasing up to 12% bagasse replacement of soil and further increase in bagasse ash the CBR valued dropped. The initial CBR of virgin soil was found to be 6.32% which was increased up to 11.91% at 12% replacement of bagasse ash..

TABLE 4
EFFECT ON CBR VALUE OF SOILWITH DIFFERENT PROPOTION OF BAGASSE ASH

Description	CBR 2.5mm	CBR 5mm
Virgin Soil	6.32	5.47
Virgin Soil replaced by 4% BA	8.18	6.22
Virgin Soil replaced by 8% BA	9.67	8.70
Virgin Soil replaced by 12% BA	11.91	10.19
Virgin Soil replaced by 16% BA	8.56	7.96

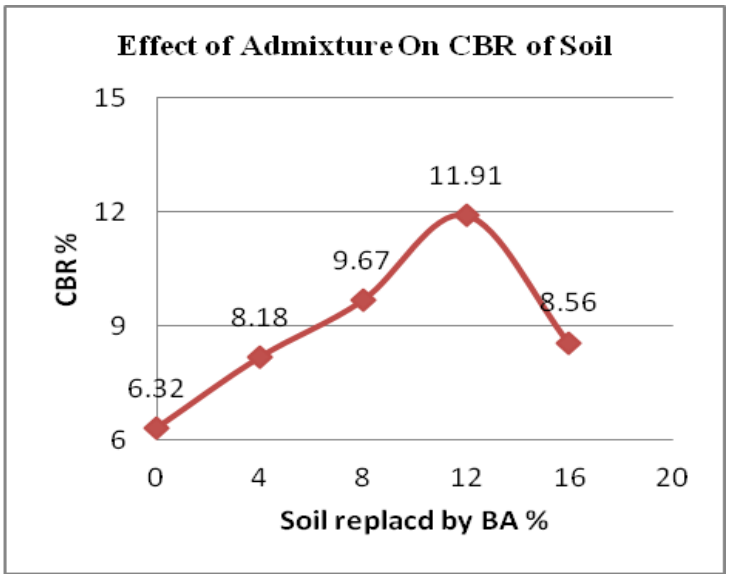


Fig.10 Effect of sugarcane bagasse ash on CBR of Soil

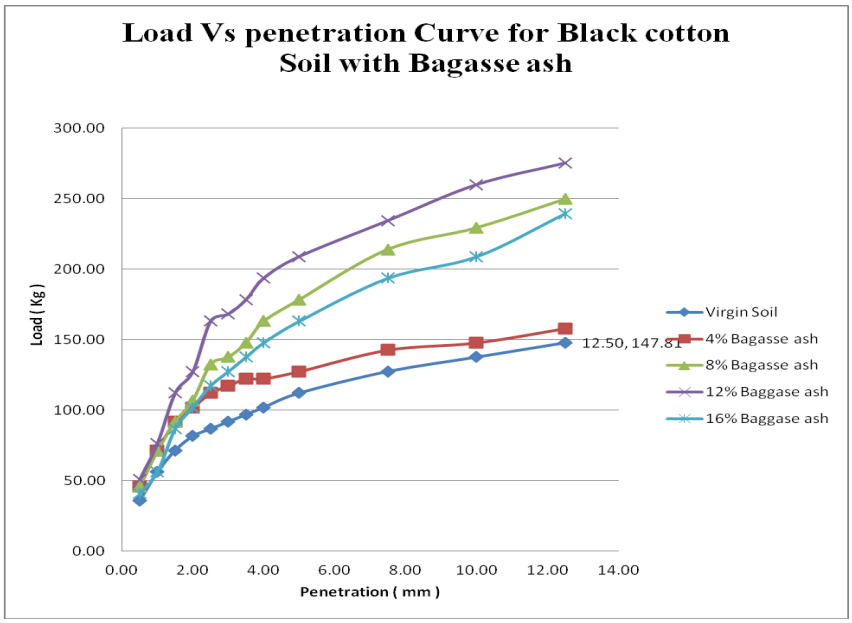


Fig.11 Load Penetration Curve for Black Cotton Soil replacement with Bagasse ash



Fig.12 Soil Specimen after CBR test



Fig.13 Static Compaction of Mould under UTM

Free Swell Index:

The free swell index is carried out on virgin soil and for every mix of soil with replacement of bagasse ash. The variation of swelling with increase in bagasse ash is shown in table no.5 below, With increase in bagasse ash content the swelling of black cotton soil is found to be decreasing. The initial swelling of black cotton soil was 55.56% which was reduced to 40% at 16% of bagasse ash replacement.

TABLE 5
EFFECT ON SWELLING PROPERTIES OF SOILWITH DIFFERENT PROPOTION OF BAGASSE ASH

Description	Vd	Vk	Swelling %
Virgin Soil	14	9	55.56
Virgin Soil replaced by 4% BA	15	10	50
Virgin Soil replaced by 8% BA	14.5	10	45
Virgin Soil replaced by 12% BA	15	10.5	42.86
Virgin Soil replaced by 16% BA	14	10	40

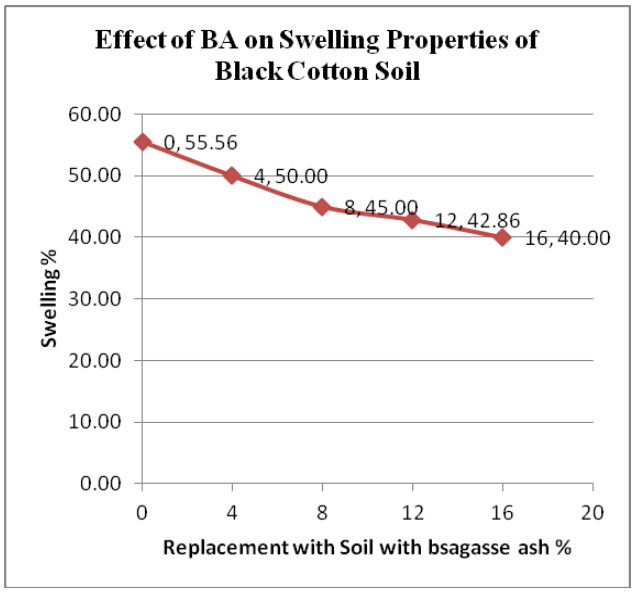


Fig.14 Effect of admixture on Swelling Properties of Black Cotton Soil

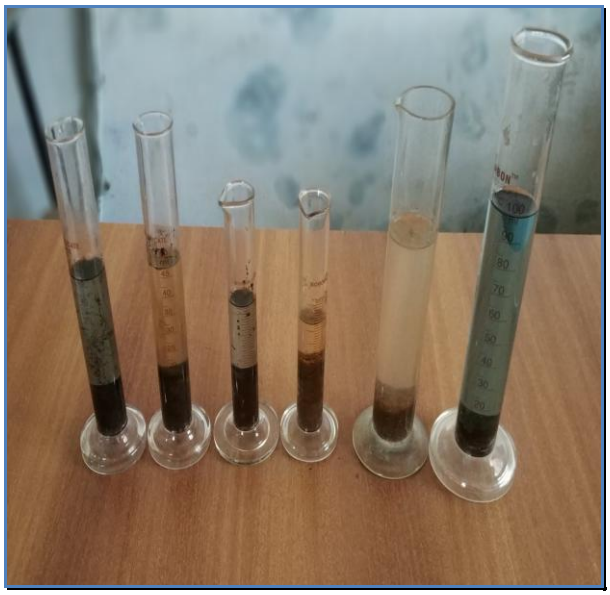


Fig.15 Free Swell Index Test

Consistency Limits:
The liquid limit and plastic limit of the soil with different proportion with sugarcane bagasse ash is show in table no.6 The liquid limit and plastic limit starts decreasing with addition of sugarcane bagasse ash. With addition of sugarcane bagasse ash and shows decreasing in plasticity index which shows decrease in amount of clay content of soil hence decrease in swelling properties.

TABLE 6
EFFECT ON CONSISTENCY OF SOILWITH DIFFERENT PROPOTION OF BAGASSE ASH

Description	Liquid Limit (WL)	Plastic Limit (WP)	Plasticity Index (IP)
Virgin Soil	67.36	32.75	34.61
Virgin Soil replaced by 4% BA	62.11	31.33	30.78
Virgin Soil replaced by 8% BA	60.08	29.98	30.10
Virgin Soil replaced by 12% BA	57.33	28.67	28.66
Virgin Soil replaced by 16% BA	54.96	27.08	27.88

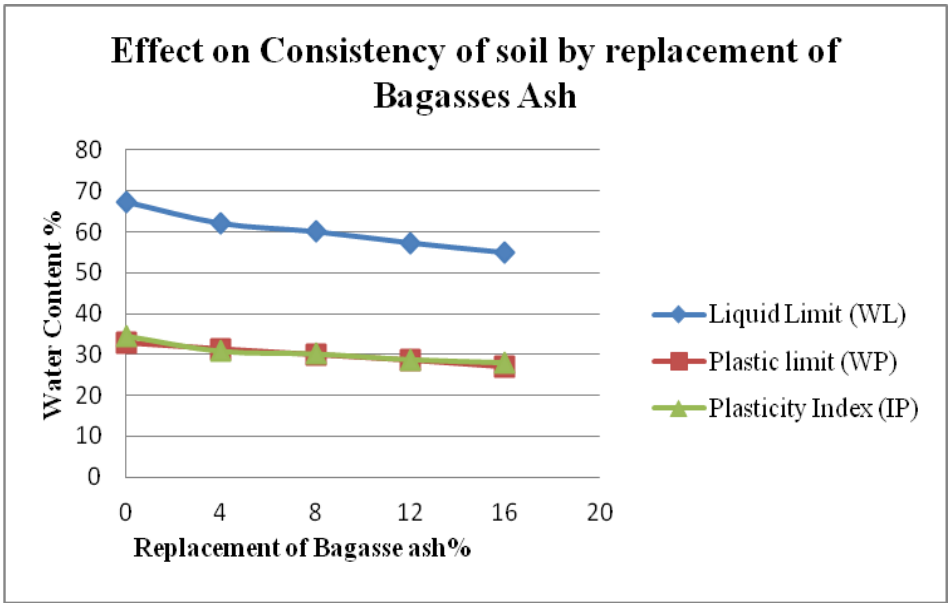


Fig.16 Effect on Consistency of Soil with replacement



Fig.17 Liquid limit Test



Fig.18 Plastic limit Test

V. CONCLUSIONS

After performing the various test in the laboratory with different proportions of bagasse ash replaced by black cotton soil it is observed that there is increases CBR value of the soil with increase in bagasse ash proportion which is found maximum at 12% replacement of soil with bagasse ash as shown in fig no.10 . The CBR value of virgin soil increased by 88.45% from 6.32 to 11.91 at 12% replacement of bagasse ash. Further with addition of bagasse ash there is reduction in swelling properties of black cotton soil which is reduced to 40% from 55.56% as shown in fig.14. And it also shows reduction in plasticity index. Thus it can be concluded that this method of stabilization of soil with replacement of sugarcane bagasse ash can be used for improve strength and swelling properties of poor black cotton soil.

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