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STABILIZATION OF BLACK COTTON SOIL USING BAGASSE ASH

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ABSTRACT:
The base of a structure is the soil, which supports the superstructure and foundation while assisting in evenly distributing the load. Settlement and cracking are signs of structural failure if the soil stability is insufficient. Due to the presence of a mineral called montomorillonite, which experiences shrinking and swelling, black cotton soil is also known as expansive soils, which is what causes such circumstances. To combat this, a mechanical and chemical procedure called as soil stabilisation is used to enhance the qualities of soil. There have been numerous studies done on stabilising soil using cement, chemicals like fly ash, calcium chloride, sodium chloride, etc. In India, just a few strategies are used to dispose of agricultural waste. India produces 341,400 thousand metric yearly tonnes (TMT) of sugarcane annually, which ranks it second in the world. Western Maharastra was a pioneer in the large-scale production of sugarcane. Sugar mills produce trash after extracting sugarcane juice using machinery. This garbage is burned to produce bagasse ash. It is composed of fibrous material that enhances the physical qualities of black cotton soil by being puzzolonic and silica in nature. In black cotton soil, experiments are carried out by substituting bagasse ash (4%, 8%, 12% and 16%) to varying degrees. By substituting untreated bagasse ash, the characteristics of black cotton soil are boosted by 8%.

Keywords:
Soil Stabilization, Maximum Dry Density, Unconfined Compression Test, Black Cotton Soil, Bagasse Ash etc.,

I. INTRODUCTION

The alteration of soil to enhance its physical characteristics is known as soil adjustment. By improving the shear quality of the soil or even controlling its swell characteristics, adjustment might increase the heap cost while making the greatest use of resources that are readily available locally. One of the more popular methods of adjustment involves mixing customary coarse- and fine-grained soil to produce a blend that sufficiently produces interior grinding and union and, as a result, produces a material that is workable in a variety of conditions. "Mechanical stabilisation" refers to the reworking of soil particles through some form of mechanical compaction.Establishing Stabilization is the process of adding solidifying materials to soil, such as cement, lime, bitumen/blacktop, and so on. Compound adjustment is the process of adding chemicals to soil, such as calcium chloride and sodium chloride. Agricultural wastes as soil stabilisers was explored by [Chittaranjan, M., Vijay, M., Keerthi,D. (2011)]. A agricultural waste called sugar cane bagasse ash stabilises the unstable subgrade soil. The weak subgrade soil is treated with 0%, 3%, 6%, 9%, 12%, and 15% bagasse ash. For each percentage, a CBR

test is conducted.The results of these tests indicated that the CBR value improved as the percentage of bagasse ash rose.
The amount of conventionally added compounds used for soil adjustment has increased as a result of recent innovation. These unconventional stabilisers include fibre support, copolymer-based products, calcium chloride, sodium chloride, and polymer-based goods (such as cross-connecting water-based styrene acrylic polymers that collectively improve the heap carrying limit and flexibility of treated soils). The qualities of foundation soils are improved to their greatest strength and durability. The moisture content of many soils is altered by differential expansion and shrinkage. A lot of earth will crumble under moving loads.Even when the soil is saturated, there is still a significant reduction in volume and strengthening to the point where they can support the imposed load. Stabilization is the process of treating soil to increase its stability. The kind and level of stabilisation determine the cost and suggested uses for the stabilised soil combination. Due to the efficient use of local resources, the expense is also decreased. [Osinubi, K. J. (2000)] had investigated the impact of bagasse ash on the black cotton soil's compressive strength after lime stabilisation.
The mixture of 8% lime and 4% bagasse ash produced the greatest CBR value. [Manikandan, A. &Monganraj,M.(2014)] examined the effects of bagasse ash addition (up to 10%) on the following variables: wL, wP, IP, sL, shrinkage index (sI), free swell index, and Ps. All of these parameters fell as the percentage of bagasse ash increased. Mechanical, chemical, and polymer/alternative soil stabilisation methods are the most significant.One of the earliest methods of soil stabilisation is mechanical, which involves physically altering the soil's properties, affecting its gradation, firmness, and other features. Another kind is dynamic compaction, which involves repeatedly dropping a large weight onto the ground at regular intervals to create a uniformly packed surfacehad discovered that bagasse ash and lime manage expansive soil's consolidation qualities more successfully than bagasse ash alone. All of these techniques rely on mixing substances into the soil that will alter its characteristics and interact with it physically. Compared to conventional methods, polymers and eco-friendly materials have a number of important advantages. They are more affordable and efficient than conventional techniques. Compared to many chemical solutions, eco-friendly products are substantially less hazardous to the environment.
The primary goal is to evaluate the qualities of black cotton soil for different amounts of bagasse powder in replacement of 4%, 8%, 12% and 16%.

II.LITERATURE REVIEW

1. SOIL STABILIZATION MATERIALS:

A. Soil stabilization using cement

The end result of soil stabilisation with cement is soil cement. The cementing activity during the hydration reaction is caused by chemical reactions between the cement and the siliceous soil. The key elements influencing the soil-cement are its nature, the circumstances of mixing, compaction, curing, and admixtures. Cement should be supplied in the right quantity for the various types of soil. These are listed below. Sand is 7 to 12%, Silt is 12 to 15%, Clay is 12 to 20%, and Gravel is 5 to 10%.

B. Soil stabilization using Lime

Sandy soils and heavy polymeric clayey soils can both be effectively treated with slaked lime. Using lime, you can combine cement, bitumen, or fly ash.

C. Soil stabilization using Bitumen

Bituminous materials, including as bitumen, asphalt, and tars, are used in the construction of pavement. Several forms of bitumen are available, including oiled earth, soil bitumen stabilisation, and sand bitumen stabilisation.
Depending on the kind of soil, a chemical when added to a soil either results in cohesiveness or less water absorption.

D. Chemical stabilization of soil

Calcium chloride has the ability to draw moisture from soil surfaces and bases that have been mechanically stabilised and hold it there. Calcium chloride can be used to compact the soil and make it flocculent. Calcium chloride application on a regular basis is essential for compensating for chemical losses caused by leaching activity. For the salt to work, the atmosphere's relative humidity needs to be greater than 30%.

E. Soil stabilization by Electric methods

The electrical stabilisation of clayey soils is carried out using the pricey electro-osmosis technology, which is highly beneficial for draining cohesive soils.

F.Soil stabilization by Grouting

Stabilizers are injected into the soil using this technique. Because to the low permeability of clayey soils, this approach cannot be used on them, and it is also expensive. Several grouting procedures are categorised, and these approaches can stabilise subterranean zones to a certain level.

There are several different types of grouting procedures, including bituminous grouting, polymer grouting, chrome lignin grouting, and clay grouting.

G.Soil stabilization using fabrics and Geotextiles

Synthetic materials including polyvinyl chloride, polyester, polyethylene, and nylons are used to create geotextiles. These are porous fabrics that are divided into many forms, including woven,grid-shaped and nonwoven. Furthermore, geotextiles give soil exceptional strength.

2. BLACK COTTON SOIL AND BAGASSE ASH:

Because of its characteristics, black cotton soil is particularly problematic, harmful, and dangerous. When dry, the dark cotton soil is hard; nevertheless, when wet, it completely loses its qualities. Using the dark cotton soils for development is extremely difficult due to their poor quality and susceptibility to unneeded volume changes. All of the black cotton soils are not productive soils, nor are all of the broad soils black in colour. These soils were of high quality in the summer but fell off swiftly in the winter. Sweeping dirt expands and contracts, causing considerable damage to the establishment, structures, streets, holding structures, and trench linings.Bagasse is a deposit produced when bagasse is consumed in factories that make sugar. Bagasse is the cell-sinewy waste product left over after stick plants' sugar juice is extracted. Nowadays, it is used to create construction materials, mash and paper products, and as a biofuel. A sugar processing facility produces almost 3 tonnes of wet bagasse, a byproduct of the production of sugar sticks, for every 10 tonnes of sugarcane crushed. When this bagasse is burnt, the flaming debris that results is bagasse powder. Although Western Maharashtra has the most sugar processing plants, these facilities struggle with the conveyance of large amounts of bagasse.The requirements for soil stabilisation are to improve soil quality, control soil swelling and psychologist characteristics, reduce soil compressibility to lessen settlement when structures are built on it, improve soil toughness, and influence soil to water sealing.

III.METHODOLOGY

The process consists of several steps.

1. Purchasing of materials
2. Getting ready a soil sample
3. To test the prepared soil sample in order to determine the soil sample.
4. To use varying amounts of bagasse ash to treat the soil sample.
5. To analyse a sample that has been treated with bagasse ash

A.Procurement of material

1) Black cotton soil from Pulivendula is used.At a depth of 1 m below earth, dirt was gathered.

2) Sugarcane Bagasse Ash Sugarcane bagasse is purchased from online.

Bagasse was exposed to sunlight for 24 hours before being burned to produce ash. To obtain fine powdered ash, the generated ash was collected and sieved using a 425 micron sieve.

3) Soil Sample Preparation

To get rid of lumps, the black cotton soil is spread and hammered.The soil is stored in a container after passing through a 2.36 mm sieve.

4) Four tests were performed on the soil sample: the Atterberg limits test, the standard proctor test, and the unconfined compression test.

5) Treatment of Soil Sample with Various Bagasse Ash Ratios

Testing is done after adding bagasse ash to soil in amounts of 4%, 8%, 12%, and 16%. Bagasse ash is a stabilising agent.

6) Common Proctor Compaction Examination

The process of compaction is used to reduce soil's air voids. The level of compaction is established by dry thickness. The wet soil sample blend yields the correct water content and dry thickness.

B. Unconfined Compression Test

Since it is one of the quickest and least expensive methods for determining shear quality, the unconfined pressure test is by far the most often used method for soil shear testing. The technique is mostly used with submerged, firm soils recovered from thin-walled test tubes. For dry sands or brittle muds, the unconfined pressure test is inappropriate since the materials would deteriorate in the absence of a parallel confinement. The goal of this test is to determine the dirt's unconfined compressive quality.

IV. Analysis and Discussions

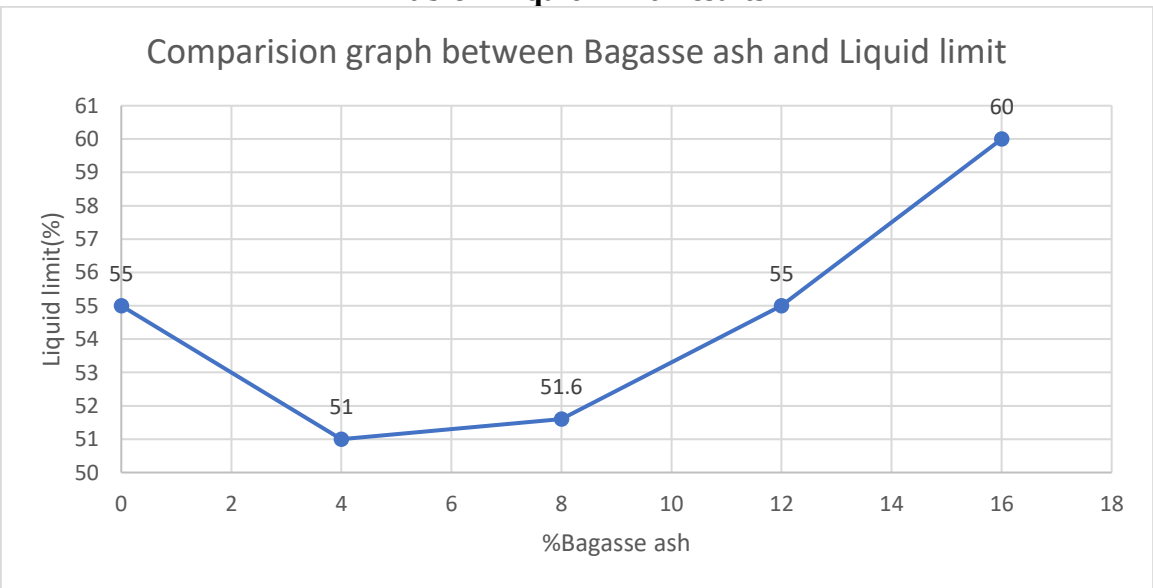
The initial water content of the black cotton soil, which is removed from the foundation, was high. Liquid limit, plastic limit, compaction test, and unconfined compression test results were obtained for the soil. The outcomes of the original soil without the addition of sugar cane bagasse are as follows:

A) Soil Results

1.Liquid limit

Liquid limit	%
Liquid limit of normal soil sample	55%
Liquid limit of soil sample with 4% of Bagasse ash	51%
Liquid limit of soil sample with 8% of Bagasse ash	51.6%
Liquid limit of soil sample with 12% of Bagasse ash	55%
Liquid limit of soil sample with 16% of Bagasse ash	60%

Table I Liquid limit Results

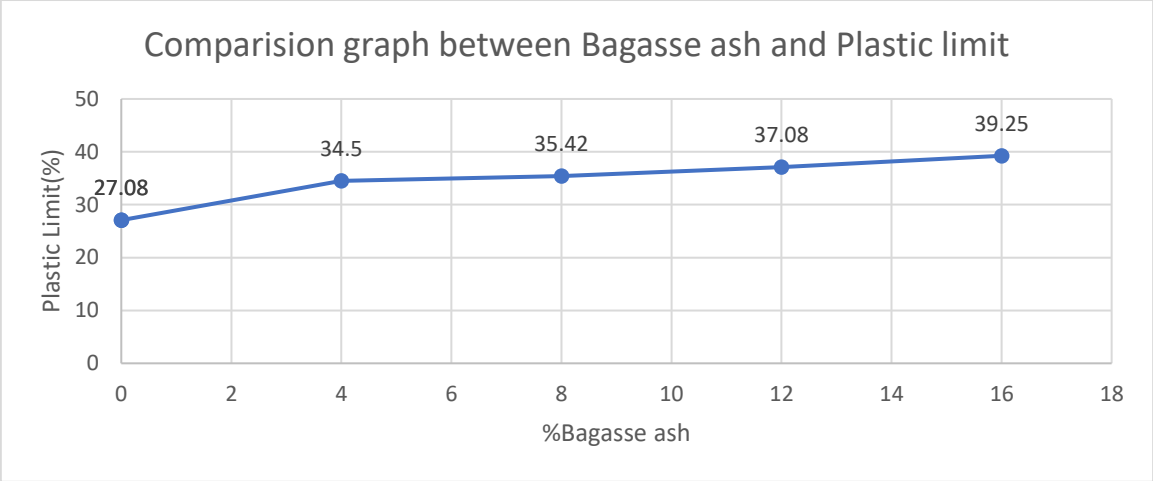


2.Plastic limit

Plastic limit	%
Plastic limit of normal soil sample	27.08%

Plastic limit of soil sample with 4% of Bagasse ash	34.5%
Plastic limit of soil sample with 8% of Bagasse ash	35.42%
Plastic limit of soil sample with 12% of Bagasse ash	37.08%
Plastic limit of soil sample with 16% of Bagasse ash	39.25

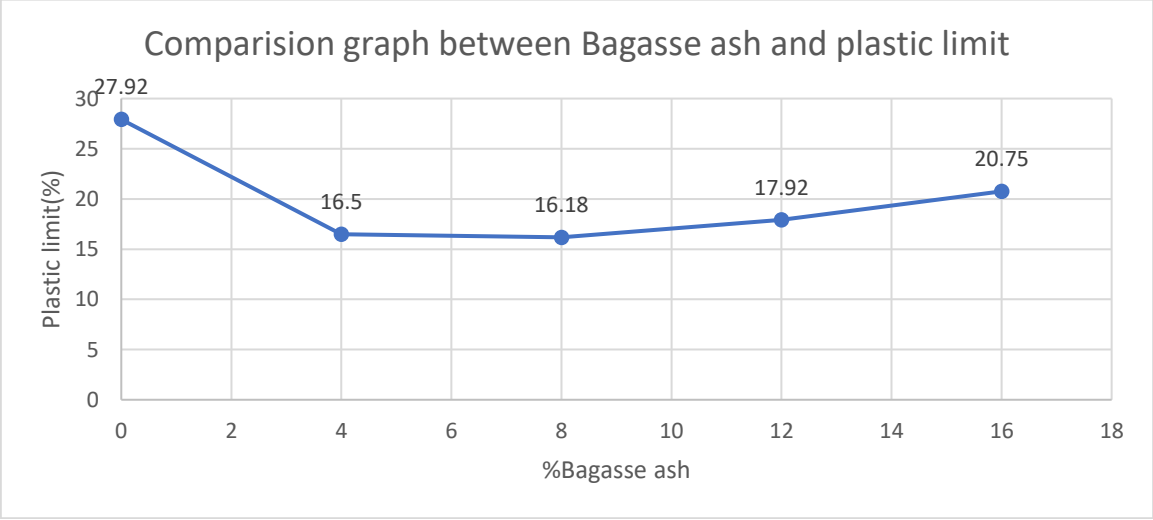
Table II Plastic limit Results



3.Plasticity index

Plasticity Index	**%**
Plasticity index of normal soil sample	27.92%
Plasticity index of soil sample with 4% of Bagasse ash	16.5%
Plasticity index of soil sample with 8% of Bagasse ash	16.18%
Plasticity index of soil sample with 12% of Bagasse ash	17.92%
Plasticity index of soil sample with 16% of Bagasse ash	20.75%

Table III Plasticity Index



According to the plasticity index values mentioned above, 8% of the soil's weight should be added as an admixture (bagasse ash). Because clayey soil is highly plastic, it can cause issues in the construction industry. Hence, stabilising it with 8% of its weight in bagasse ash can give the soil the needed strength.

B) Compaction Test

Original soil sample

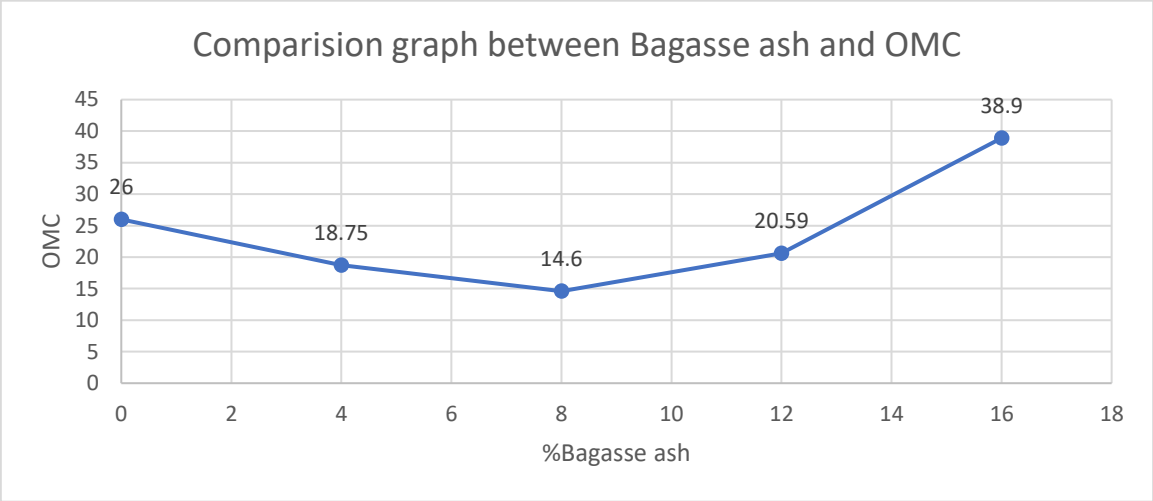
The optimum moisture content is 26%

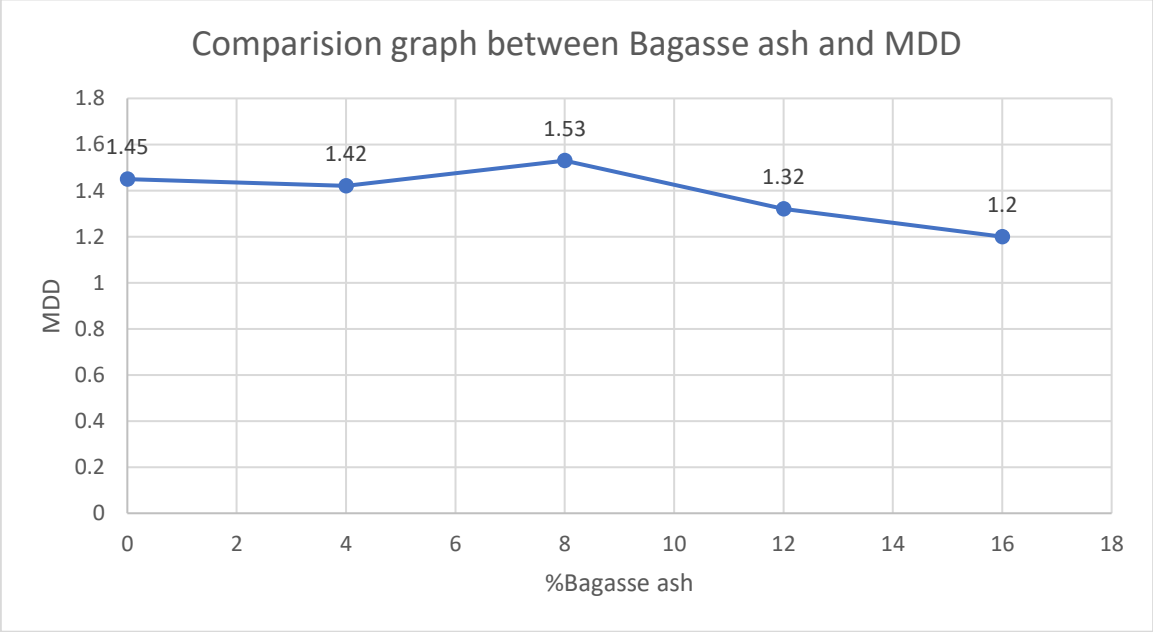
The maximum dry density is 1.45 g/cc

%Bagasse ash	Optimum moisture content	Maximum dry density
4%	18.75	1.42

8%	14.6	1.53
12%	20.59	1.32
16%	38.9	1.2

Table IV compaction test results with Bagasse ash





According to the compaction test results above, 8% of the soil's weight should be added as an admixture (bagasse ash). Clayey soil has a high water content, which causes issues in the construction industry. Hence, stabilising it with bagasse ash at a weight of 8% can provide the soil the needed strength.

C) California Bearing Ratio

Original soil sample

CBR Value @2.5mm is 4.9

CBR Value @5mm is 3.94

%Bagasse ash	CBR Value @ 2.5mm	CBR Value @ 5mm
4%	5.46	5
8%	6.9	6.8
12%	5.9	5.7
16%	4.35	4.32

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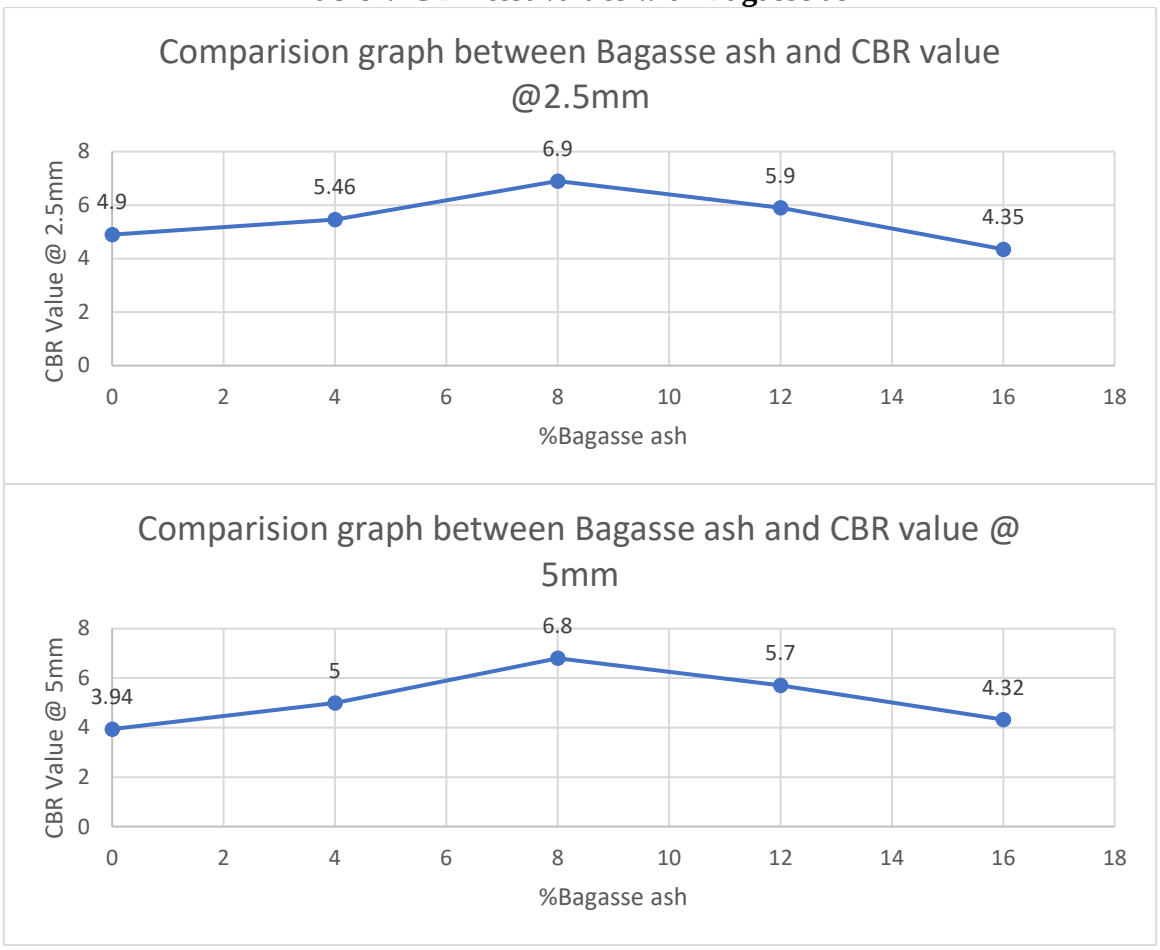
Table V CBR test values with Bagasse ash



According to the CBR test results above, 8% of the soil's weight should be added as an admixture (bagasse ash).Clayey soil has less bearing capacity, which causes issues in the construction industry. Hence stabilising it with bagasse ash at a weight of 8% can provide the soil needed bearing capacity.

D) Unconfined Compression Test Results

Original Soil

The unconfined compressive strength is0.36 N/mm²

The shear strength for this soil is0.16 N/mm²

%Bagasse ash	Unconfined compressive strength	Shear strength
4%	0.38	0.175
8%	0.42	0.21
12%	0.39	0.1812

Table VI Unconfined Compression test Results

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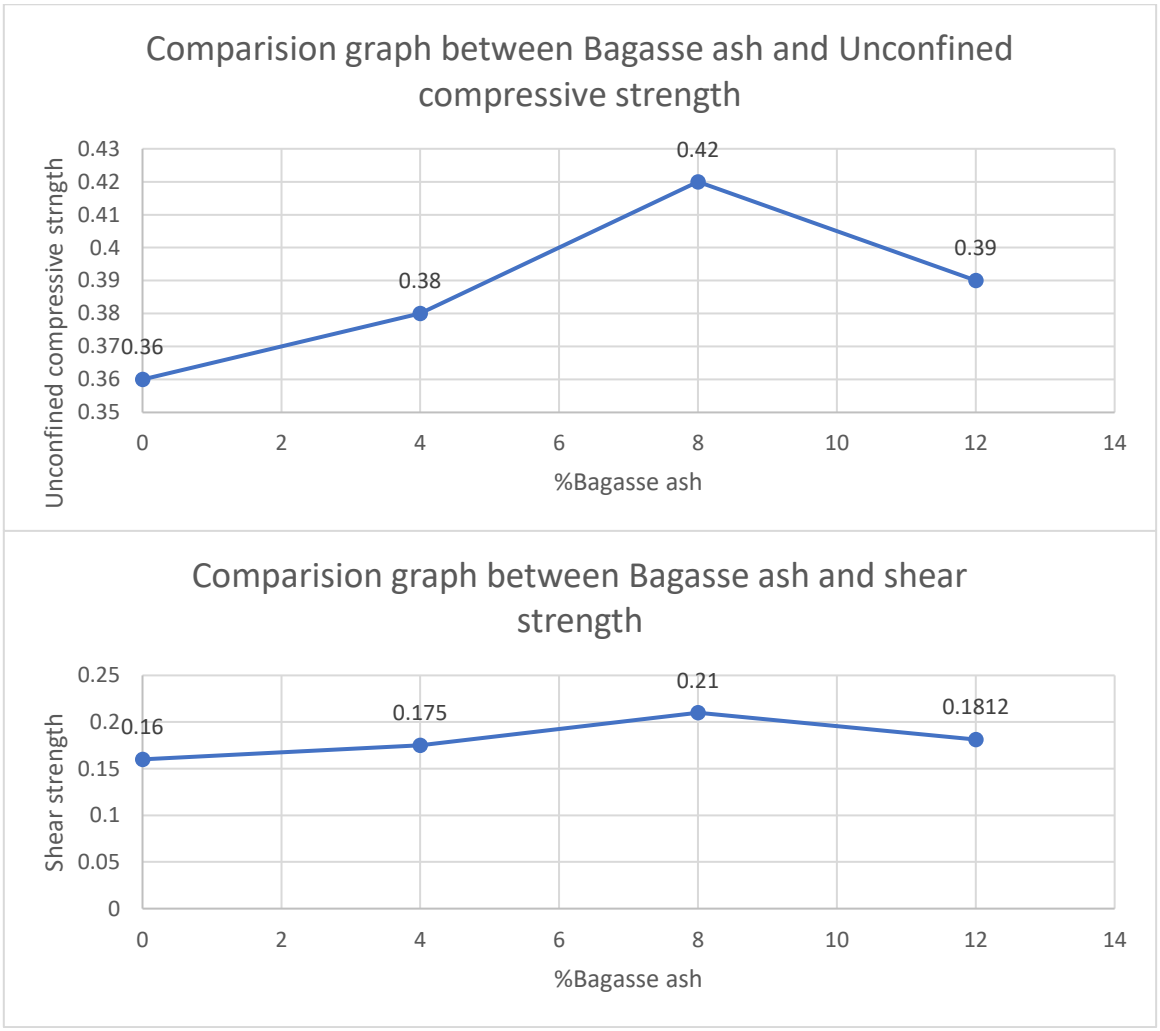

We may infer from the unconfined compression test's aforementioned results that the ideal dosage of admixture (bagasse ash) is 8% of the soil's weight. Because clayey soil is fragile and problematic in the construction industry. Hence, stabilising it with bagasse ash at 8% of its weight can provide the soil with the appropriate shear strength.

VI Conclusions and Result

Strengthening of black cotton soil through soil stabilisation techniques. The results of our research work include the followings are:

• At 8% bagasse ash dose, the plasticity index decreased from 16.5% to 16.18%, which is preferable for construction sites.

• At 8% dose of bagasse ash, the maximum dry density increased from 1.45gm/cc to1.53g/cc.

• At 8% dose of bagasse ash, the CBR value @ 2.5mm is increased from 4.9 to 6.9.

• At 8% dose of bagasse ash, the CBR value @ 5mm is increased from 3.94 to 6.8.

• At 8% dose of bagasse ash, the unconfined compressive strength is increased from 0.36 N/mm² to 0.42 N/mm².

• At 8% dose of bagasse ash, the shear strength is increased from 0.16N/mm² to 0.21 N/mm²

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