A Study on Soil Stabilization using Sugarcane Bagasse Ash

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Abstract*: Soil is the base of a structure which helps in equally distributing the load and supports the super structure and foundation. If the soil stability is not adequate then failure of structure takes place in form of settlement,cracks. Black cotton soil are also called as expansive soils which is is responsible for such situations and is due to presence of mineral called montmorillonite in it, which experience shrinkage and swelling. To overcome this properties of soil are improved by mechanical and chemical process known as soil stabilisation. Many research has been conducted for stabilisation of soil by using cementing, chemical materials like flyash,calcium chloride, sodium chloride etc. In India, limited techniques are followed in agricultural waste disposal. India is second largest country in the production of sugarcane with 341,400 thousand metric annual tones(TMT) produce.Western Maharastra is pioneer in production of sugarcane in large quantities sugar cane factories produce waste after extraction of sugarcane juice in machines and that waste after burning produce ash known as bagasse ash. It is made up of fibrous material having silica and puzzolonic in nature which improves the physical properties of black cotton soil. Experiments are conducted on black cotton soil by partially replacing bagasse ash (4%,8%,12%,16%,20%). Black cotton soil properties of are increased at 16 % by replacing of bagasse ash not including any chemicals.

Index Choice: Soil Stabilisation, Black Cotton Soil, Bagasse Ash, Unconfined Compression Test, Maximum Dry Density)

I. INTRODUCTION

Soil adjustment is the change of soil to improve their physical properties. Adjustment can build the shear quality of soil or potentially control the swell properties of the soil, in this way enhancing the heap cost by making best utilization of locally accessible materials. One of the more typical techniques for adjustment incorporates the blending of characteristic coarse grained soil and fine grained soil to get a blend that creates sufficient interior grinding and union and along these lines gives a material that is workable amid situation. Reworking of soil particles by some of mechanical compaction is alluded as "Mechanical Stabilization". Utilization of solidifying material, for example, bond, lime, bitumen/black-top and so on is added to soil is "Establishing Stabilization" and utilization of chemicals in soil, for example, sodium chloride and calcium chloride added to soil is called compound adjustment. [1]studied the 'Agricultural wastes as soil stabilizers'. The weak sub grade soil is stabilised by sugar cane bagasse ash a agricultural waste. The weak sub grade soil is treated using bagasse ash of 0%, 3%, 6%, 9%, 12%and 15%. CBR test is carried out for each percentage. The results of these tests showed improvement in CBR value with the increased values of percentage of bagasse ash.

Late innovation has expanded the quantity of customary added substances utilized for soil adjustment purposes. Such non-conventional stabilizers include: Polymer based items (e.g. cross-connecting water-based styrene acrylic polymers that altogether enhances the heap bearing limit and elasticity of treated soils), Copolymer Based Products, fiber support, calcium chloride, and Sodium Chloride. Strength and durability of a soil is attained maximum improving the characteristics of foundation soils. Differential expansion and shrinkage changes the moisture content of many soils. Many soil crumble when they subject to moving loads. Reduction in volume and strengthening to the point where they can carry the imposed load is significant even when the soil is saturated. Treatment of soil, which makes it more stable, refers to stabilization. Availability cost and proposes of using the stabilized soil mixture is determined by type and degree of stabilization. This makes the effective utilization of local materials and simultaneously reduces the cost. [4] had studied the effects of bagasse ash on compressive strength of lime stabilized black cotton soil.

The highest CBR value was obtained at 8 % lime and 4% bagasse ash combination. [3] had studied the result of adding bagasse ash (upto 10%) on wL, wP, IP, sL, Shrinkage index (sI), Free Swell Index, Ps. There was a decrease in all these values with increase in % of bagasse ash. The most important types of soil stabilization are Mechanical, Chemical, Polymer/alternative.

Mechanical type is one of the oldest types of soil stabilization which involve in physically changing the property of the soil impacting its gradation, solidity, and other characteristics. Dynamic compaction is another type; in this a heavy weight is dropped continually onto the ground at regular intervals to ensure a uniformly packed surface.

[2] had found that the bagasse ash and lime controls consolidation characteristics of expansive soil more effectively than the bagasse ash alone. All of these methods rely on adding admixtures to the soil that will change its properties and physically interacts also. Polymers and eco friendly materials have number of significant advantages over traditional methods. They are cheaper and more effective than traditional methods. Eco friendly materials are significantly less dangerous for the environment than many chemical solutions.

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The main objective is to assess the quality attributes of dark cotton soil for various extents of bagasse powder in substitution of 4%, 8%, 12%, 16%and 20%.

II SOIL STABILIZATION MATERIALS

A. Soil stabilization using cement

Soil cement is the product of soil stabilized with cement. During hydration reaction, the cementing action takes place by the chemical reactions of cement with siliceous soil. Nature of soil content, conditions of mixing, compaction, curing and admixtures are the important factors affecting the soil-cement. For different types of soils appropriate amounts of cement should be provided. They are as follows Gravel – 5 to 10%, Sand – 7 to 12%, Silt – 12 to 15%, and Clay – 12 – 20%.

B. Soil Stabilization using Lime

Heavy plastic clayey soils and Sandy soils can be treated effectively with Slaked lime. Cement, bitumen or fly ash can be used with the combination of Lime.

C. Soil stabilization with bitumen

Pavement construction is made by bituminous materials like bitumen Asphalts and tars. Sand bitumen stabilization, Soil Bitumen stabilization, Oiled earth are different types of bitumen available.

A substance when added to a soil, it follows both cohesion and reduced water absorption depending on the nature of soils.

D. Chemical stabilization of soil

Calcium chloride is able to absorb and hold moisture in soil bases and surfacing which are stabilized mechanically. compaction and soil flocculent can be done by Calcium chloride. Frequent application of calcium chloride plays a vital role in make up for the chemical losses by leaching action. The relative humidity of the atmosphere should > 30% for the salt to be effective.

E. Soil stabilization by electrical methods

An expensive method called electro-osmosis method is performed by electrical stabilization of clayey soils of soil stabilization and very useful for drainage of cohesive soils.

F. Soil stabilization by grouting

In this method, stabilizers are injected into the soil. The main limitations of this method are, it is not applicable for clayey soils because of their low permeability and expensive also. Various grouting techniques are classified and these methods are suitable for stabilizing zones buried zones to certain extent limit.

The Various types of grouting techniques are Clay grouting, Chemical grouting, Chrome lignin grouting, Polymer grouting and Bituminous grouting

G. Soil stabilization using fabrics and Geotextiles

Geotextiles are made up of synthetic materials such as polyvinyl chloride, polyester polyethylene, nylons. They are porous fabrics and classified into different types like woven, non-woven and grid form. Geotextiles also yield high strength to soil.

III. BLACK COTTON SOIL AND SUGAR CANE BAGASSE ASH

Black cotton soil is exceptionally troublesome and risky and perilous because of its attributes. The dark cotton soil is hard when dry yet loses its quality totally when in wet condition. The dark cotton soils have low quality and are vulnerable to unnecessary volume changes, making their utilization for development purposes exceptionally troublesome. All the Black cotton soils are not attaining soils and all the broad soil are not Black in shading. These dirts had high quality in summer and diminished quickly in winter. Swelling and shrinkage of sweeping soil cause respectful settlement bringing about serious harm to the establishment, structures, streets, holding structures and trench linings. Bagasse is a deposit acquired from the consuming of bagasse in sugar creating manufacturing plants. Bagasse is the cell sinewy waste item following the extraction of the sugar juice from stick plants. It is as of now utilized as a bio fuel and in the fabricate of mash and paper items and building materials. For every 10 tons of sugarcane squashed, a sugar processing plant creates almost 3 tons of wet bagasse a side-product of the sugar stick industry. At the point when this bagasse is scorched the resultant fiery debris is bagasse powder. Western Maharashtra is having greatest number of sugar industrial facilities, these processing plants faces a transfer issue of expansive amount bagasse. The requirement for soil stabilization are to increment the quality of soil, Control of psychologist and swell properties of soil, to bring down the compressibility of soil and in this manner decrease the settlement when structures are based on it, to increment toughness, to influence soil to water sealing.

IV METHODOLOGY

The methodology involves series of steps.

1. Procurement of materials
2. Preparation of soil sample
3. To conduct test on the prepared soil sample to calculate soil sample.
4. To treat the soil sample with proportions of bagasse ash
5. To conduct test on bagasse ash treated sample

A. Procurement of material

1) Black cotton soil

The soil procured from Maisammaguda is used as sample. The soil was collected at depth of 1m below ground level.

2) *Sugarcane Bagasse Ash*

the sugarcane bagasse is collected from sugarcane juice sellers in Maisammaguda.The bagasse was dried in sunlight for 24 hours and burnt to get ash. Ash formed was collected and sieved using 425 micron sieve to get fine powdered ash.

3) *Preparation of Soil Sample*

The black cotton soil is spread and is beaten to remove lumps.The soil is sieved through 2.36 mm sieve is stored in container.

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4) *Tests Conducted on Soil Sample*

- Atterbergs limits
- Standard proctor test
- Unconfined compression test

5) *Treatment of Soil Sample with Different Proportions of Bagasse Ash*

Bagasse ash is added to soil in proportions of 4%, 8%,12%and 16% and tests are conducted Stabilising agent: bagasse ash.

6) *Standard Proctor Compaction Test*

Compaction is the procedure of minimizing air voids in soil. Dry thickness establishes the compaction level. Dry thickness and the ideal water content are obtained from the wet soil sample blend.

B) Unconfined Compression Test

The unconfined pressure test is by a wide margin the most well known technique for soil shear testing since it is one of the quickest and least expensive strategies for estimating shear quality. The strategy is utilized essentially for immersed, firm soils recouped from thin-walled testing tubes. The unconfined pressure test is unseemly for dry sands or brittle muds in light of the fact that the materials would go into disrepair without some place where there is parallel imprisonment. The reason for this test is to decide the unconfined compressive quality of the dirt.

V RESULTS AND DISCUSSIONS

As the black cotton soil is collected from the foundation, the original water content was high. The soil was tested for liquid limit, plastic limit, compaction test and unconfined compression test. The following are the results of the original and sugar cane bagasse added soil are as below

A) Original Soil Results

1) liquid limit

Liquid limit	**%**
Liquid limit of original soil sample	50.2%
Liquid limit of soil sample with 4% bagasse ash	40%
Liquid limit of soil sample with 8% bagasse ash	26%
Liquid limit of soil sample with 12% bagasse ash	20%
Liquid limit of soil sample with 16% bagasse ash	42.2%
Liquid limit of soil sample with 20% bagasse ash	62.1%

Table.I Liquid limit result

2) Plastic Limit

Table.II Plastic limit result

Plastic limit	**%**
Plastic limit of original soil sample	33.33%
Plastic limit of soil sample with 4% bagasse ash	75%
Plastic limit of soil sample with 8% bagasse ash	50%
Plastic limit of soil sample with 12% bagasse ash	33.33%
Plastic limit of soil sample with 16% bagasse ash	50%
Plastic limit of soil sample with 20% bagasse ash	33.33%

3) *Plasticity Index*

Plasticity index	**%**
Plasticity index of original soil	16.87%
Plasticity index of soil sample with 4% bagasse ash	35%
Plasticity index of soil sample with 8% bagasse ash	24%
Plasticity index of soil sample with 12% bagasse ash	13.33%
Plasticity index of soil sample with 16% bagasse ash	7.8%
Plasticity index of soil sample with 20% bagasse ash	28.8%

Table.III Plasticity index

By the above values of the plasticity index, we can conclude that the optimum dosage of add admixture (bagasse ash) is 16% to the weight of soil. As clayey soil has high plasticity and that can be a problem in the field of construction. So stabilizing it with bagasse ash of 16% of its weight can give the desired strength to the soil.

B) Compaction Test

Original soil sample

The optimum moisture content is 17.4%

The maximum dry density obtained is 1.705gm/cu.c

Results with bagasse ash

% of bagasse ash	**Optimum moisture content**	**Maximum dry density**
4%	16.38	1.56
8%	15.9	1.59
12%	14.7	1.62
16%	9.09	1.73
20%	12.2	1.63

Table.IV Compaction test result with bagasse ash

By the above values of the compaction test, It is concluded that the optimum dosage of add admixture (bagasse ash) is 16% to the weight of soil. As clayey soil has high water content and that creates problem in the field of construction. So stabilizing it with bagasse ash of 16% of its weight can give the desired strength to the soil.

C) Unconfined Compression Test Results

Original soil

The unconfined compressive strength is 0.241 N/ mm^2

The shear strength for this soil is 0.1205 N/ mm^2

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Soil with Bagasse Ash

% of bagasse ash	Unconfined compressive strength	Shear strength
4%	0.362	0.181
8%	0.439	0.2195
12%	2.482	1.2141
16%	4.355	2.1775
20%	3.453	1.726

Table.V Unconfined compression test results

By the above values of the unconfined compression test, we can conclude that the optimum dosage of add admixture (bagasse ash) is 16% to the weight of soil. As clayey soil is weak and causes problem in the field of construction. So stabilizing it with bagasse ash of 16% of its weight can give the desired shear strength to the soil.

VI CONCLUSION

Soil stabilization method can increase the strength of black cotton soil. In our project the following results are obtained:

- At 16% dosage of bagasse ash the plasticity index reduced from **16.87%** to **7.8%** which is desirable for construction site
- The maximum dry density improved from **1.705 gm/cc** to **1.73 gm/cc** at **16%** dosage of bagasse ash
- The unconfined compressive strength increased from **0.241 N/ cm^2** to **4.355 N/cm^2** at **16%** dosage of bagasse ash
- The shear strength improved from **0.1205 N/cm^2** to **2.177 N/cm^2** at **16%** of bagasse ash

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