Experimental Study on Black Cotton Soil to be used as Filling Material by Strenghtning With Baggasse Ash and Brick Dust

Tulasi Sai Krishna, Noorbasha Sanil Basha, Karri Shyam Chamberlin

Abstract: ***Our newly proposed APCRDA area most of the surface is occupied by black cotton soil. On the black cotton soil various civil engineering applications will appear for example pavement designs, structural buildings likewise. Black Cotton soil is an expansive soil. That is the reason it can absorb water and change the volume. Not only changing volume, it can also show swelling and shrinking. This is the reason structures will fail. The damage due to settlement of soil, if soil settles foundation support will be sinking, then structure will be fail. Many problems are recorded with the Black Cotton soil, to overcome the problem civil engineers and geotechnical engineers ate found many techniques. The present experimentation is with Bagasse Ash (BA) and Brick Dust (BD). The experimentation focused on physical properties of soil, compressive test, Shear Strength tests, and Swell Pressure test.***

Do the experimentation with and without adding additives, compare with those two randomly adding percentages 15%, 20%, 25%, 30%, 35% Brick Dust. Bagasse Ash is contently 10%.

This experimentation shows clearly difference of the strength of soil. Experimentation can conclude Bagasse Ash and Brick Dust is good stabilization materials for black cotton soil.

Index Terms: Black cotton soil, Bagasse Ash, Brick Dust, physical properties, Shear Strength tests, Swell Pressure test, compressive test

I. INTRODUCTION

Black cotton soils are comes under expansive soils. because of growing cotton crop and that soil minerals alumina, iron materials that soil known as black cotton soil. 3%of world occupies black cotton soil area (i.e about 340 million hectares). west indies, huge area of Russia black cotton soil occupy. In India 24% (60 million hectares) of land black cotton soil surface. the states Gujarat, Maharashtra, Madhya Pradesh, Andhra Pradesh, Karnataka and Tamilnadu are having more amount of surface black cotton soil. When the engineering structures arrived on the black cotton soil definitely getting settle, than show that soil swelling and shrinking nature experiences to us and also changing moisture content. Depends upon stress level on the surface. Mainly design on expansive soil is challenging to the geotechnical engineers. Montmorillonite is highly present in black cotton soil, it is phyllosilicate minerals which is very soft nature renders high degree of expansiveness. The amount of water content decide the strength properties of the soil. Black cotton soil behavior degree of saturation and depth of water table. The fine-grained soil engineering behavior is depends on water content. Main index properties of the classification of fine-grained soil by the Atterberg limits. Atterberg limits are plastic limit, liquid limit and shrinkage limit are important parameters of plastic index. When the dry state black cotton soil very hard and possess high bearing capacity. black cotton soil shows 50% to 100 % range of liquid limit,20 % to 65% range of plasticity index and 9% to 14% ranging shrinkage. With the increasing of plasticity index the amount of swelling generally increase. Types of clay mineral, crystal lattice structure, cation exchange capacity, ability of water absorption, density and water content decide the swelling

Stabilization

Stabilization is the process of blending and mixing of materials with a soil to improve the soil's strength and durability.

II. REQUIREMENT OF SOIL STABILIZATION

Expansive soil is not suitable for the heavy stress designs, black cotton soil are most prevalent cause of damage to building construction. The construction on black cotton soil it will get settled after completed the work. Without stabilization construction on black cotton soil is known huge risk. such kind of construction can be turn as immense loss to economy.

The damages that can be construction on swelling soil can be

- Severe damaged structures
- Driveways, sidewalks and basement flooring are getting cracked
- Roads and highway structures
- Pipelines and sewer lines are disruption

III. STABILIZING AGENTS

These are hydraulic (primary binders) or non-hydraulic (secondary binders) materials that when in contact with water or in the presence of pozzolanic minerals reacts with water to form cementitious composite materials. The commonly used binders are:

- Cement
- Lime
- Fly ash
- Blast furnace slag
- Pozzolanas
- Bagasse ash
- Brick dust

Revised Manuscript Received on April 09, 2019.

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IV. RESEARCH SIGNIFICANCE

Following significance are proposed for the present study

1. Reduce the swelling and shrinking nature of the black cotton soil and minimize the problems with that
2. To rise the unconfined compressive strength of soil by using additive like brick dust and bagasse ash.
3. To make the construction more economical in terms of both cost and energy

V. MATERIALS TO BE USED

A. Black Cotton Soil

Black cotton soil is a type of expansive soil, which is having high swelling and shrinking nature. In India major soil deposit is this soil only. This soil contains iron, alumina, magnesia with high quality and lime also. Because of the iron and alumina soil is brown, black and dark in colour meaning. From the volcanic eruption black cotton soil is arrive. Due to weathering of lava which is from volcano cooling and turning the black cotton soil, clay particles are shown in the figures.

Fig. 1 shows the black cotton soil that is used and Table I gives the Properties of Black Cotton Soil.

Fig. 1: Black cotton soil

Table I: Properties of Black Cotton Soil

Properties	Range
Liquid limit (w_l)	40 – 100 %
Plasticity index (I_p)	20– 60 %
Shrinkage limit (w_s)	8– 18 %
Volumetric shrinkage	40– 50%
Differential free swell (free swell index)	20- 100%

B. Brick dust

Brick dust is a powder of bricks, when the construction work area we can find the brick dust. Bricks also having mechanical properties like Compressive strength, Flexural strength. Durability absorption, frost resistance, Efflorescence. By adding of brick dust volume also change. bricks dust is from Chirravuri near to the Mangalagiri to Tenali road.

Fig. 2 shows the brick dust and Table II informs Characteristics of brick dust

Fig. 2: Brick Dust

Table II: Characteristics of brick dust

Chemicals	Percentages(%)
Silica	40-60%
Aluminum	10-30%
Lime	<10%
Magnesia	<1%
Ferric oxide	<7%
Alkalis	10%
Carbon dioxide	Very small percentage
Sulphur dioxide	
Water	

C. Bagasse Ash:

The waste which is produced from sugarcane is known as bagasse. Making of ash with that bagasse is called bagasse ash. Delta sugar limited and Coolex industries pvt ltd. Fig. 3 shows the bagasse ash.

Fig. 3: Bagasse Ash

Normally sugar cane are hard to find. But in Vijayawada, Eluru,Machilipatnam areas having sugar factory's there we can find the sugar canes from that sugar cane's we can prepare our stuff(Bagasse Ash) preparation of (BA): slowly burn the sugar cane and make it finer (425 microns) ash which is passing through the 425 seave . that ash is mix 10% to the required soil. Fig. 4 shows the Map locations of sugarcane factories and Table III informs the Characteristics of bagasse ash.

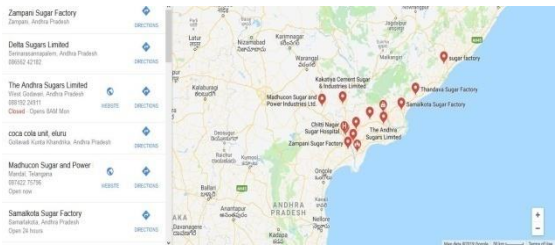

Fig. 4: Map locations of sugarcane factories

Table III: Characteristics of bagasse ash

Property	Quantity
Nominal moisture content(%)	1-2%
Liquid limit	Non plastic
Plastic limit	Non plastic
Plasticity index	Non plastic

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Liner shrinking	Non plastic
Percent of passing BS.No.200 sieve	100
Specific gravity	2.2
ASTM C-618 classification	Class N pozzolan
Color	Ash

VI. INFORMATION COLLECTED

A. Classification of expansive soils:

Generally, the soils classified as CL, CI, CH are expansive soils. The soils classified as ML, MI, MH may also be expansive. Even the soils classified as SC may be expansive in some cases. Various investigators have given the classification of expansive soils based on the index properties such as plasticity index, shrinkage limit, linear shrinkage, clay content, potential swell etc.

B. Problems with expansive soil

- Diagonal and vertical cracks in interior and exterior walls.
- Horizontal cracks in the interior and exterior walls.
- Longitudinal cracks due to the cantilever action.
- Separation of the roof slab from the interior walls.
- Leaning out of exterior walls.

3. Preventive measures for expansive soil:

- Replacement of expansive soil.
- Modification of expansive soil.
- Design of foundation to withstand against swelling

Modifications of expansive soil

- Stabilization of soil
- Compaction
- Installation of moisture barriers
- Pre wetting
- Pressure injection

VII. EXPERIMENTAL TESTS

A. Specific gravity tests

The knowledge of specific gravity is required in calculation of soil properties like void ratio, degree of saturation and also weight-volume

B. Liquid limit

The liquid limit is the moisture content at which the gouge, formed by a standard tool into the sample of soil taken in the standard cup, closes for 10mm on being given 25 blows in a standard way.

Table IV explains about the test of Atterberg limit and Fig. 5 shows the Casagrande's Liquid limit device, seave.

Table IV: Atterberg limit

Liquid limit (%)	Plasticity index (%)	Potential swell (%)	Swelling potential
<50	<25	<0.5	Low
50- 60	25 – 35	0.5 – 1.5	Moderate
>60	>35	>1.5	High

Fig. 5: Casagrande's Liquid limit device, seave

C. Unconfined compressive strength test:

The reason of this laboratory is to find the unconfined compressive strength of a cohesive soil sample. We can measure this with the unconfined compression test, which is an unconsolidated undrained (UU or Q-type) test where the lateral confining pressure is equal to zero (atmospheric pressure).

Fig. 6 shows the Unconfined compressive strength testing machine which is in koneru lakshmaiah education foundation.

Fig. 6: Unconfined compressive strength

A direct shear test is a laboratory or field test used by geotechnical engineers to measure the shear strength properties of sandy or Siltyclay soils of discontinuities in soil.

Fig. 7 shows the Direct shear machine testing machine which is in koneru lakshmaiah education foundation.

Fig. 7: Direct shear machine

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VIII. RESULTS

These are the graphs after blending additives bagasse ash and brick dust. The shear strength of the soil calculated with the graphs.

A. Unconfined compressive strength:

Fig. 8-11 shoSws the compressive strength graphs for the bagasse ash and brick dust after blending and the results of this graphs are used for the obtaining shear strength of the soil.

For Fig. 8 the compressive strength is the q_u=0.526
cohesion of soil C=0.263

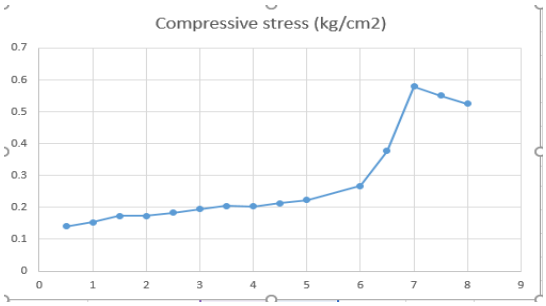

Fig. 8: Compressive strength for bagasse ash mixed soil

For Fig. 9 the compressive strength is q_u =0.197
Cohesion of soil =0.098

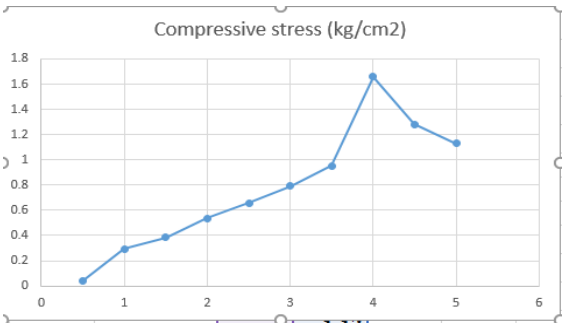

Fig. 9: Compressive strength for bagasse ash mixed soil

For Fig. 10 the compressive strength of soil q_u = 0.227
Cohesion of soil C = 0.113

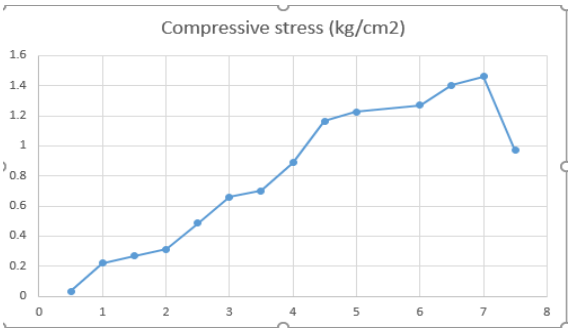

Fig. 10: Compressive strength for bagasse ash mixed soil

For Fig. 11 the compressive strength of soil is q_u= 0.250
Cohesive nature of soil is C = 0.125

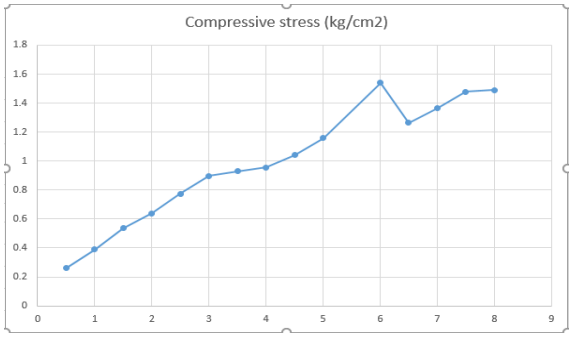

Fig. 11: Compressive strength for bagasse ash mixed soil

B. Shear Strength

With adding additives like compressive strength percentages 10% fixed bagasse ash and gradually applying 10%, 20%, 30% of Brick dust.

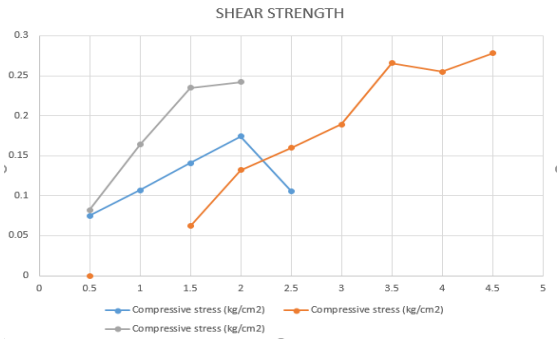

Fig. 12: Shear strength for the replaced bagasse and brick dust

The highest value is being found at 40% of mixing. So 40% of brick dust and 10% of bagasse ash will change the strength properties of soil.

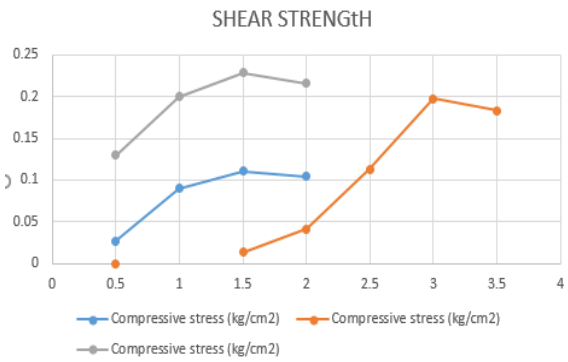

Fig. 13: Shear strength for the replaced bagasse and brick dust

Table V shows the obtained results for the replaced brick dust for 10%bagasse ash.

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Table V: Results				
Brick Dust	10%(Bagasse Ash)			
	OMC(%)	MDD (g/cc)	UCC(Mpa)	FSI
15%	17.2	1.52	0.197	84
20%	27.6	1.48	0.227	76
25%	28	1.43	0.25	57
30%	28.7	1.4	0.284	42
35%	29.4	1.32	0.312	27

IX. CONCLUSION

1. The stability tests are increasing the values while adding additives.
2. After using 30% of brick dust we can get more stability. But in certain conditions it will under the decrease.
3. According to the study. Bagasse ash increases permeability. and brick dust gives durability to the soil.
4. The soil increases stability <10%, <15%, <20%, <30%, randomly. So the usage of bagasse ash, brick dust are used for this study.
5. From black cotton soils we have observed that the addition of burnt brick dust increases the stability of soil.
6. Burnt brick dust is recommended because it is easily available, less in cost and eco-friendly material. The strength of the BC soil after interaction with burnt brick dust is given by the Atterberg's limit.
7. To attain this we have performed Plastic Limit and Liquid Limit tests . It is found that the strength of the BC soil has increased by 20%. This combination can be used to strengthen the construction sites which contain black cotton soil as the primary base

REFERENCES

1. Sabat, A.K. and Pati, S., "A Review of Literature on Stabilization of Expansive Soil Using Solid Wastes," *Electronic Journal of Geotechnical Engineering*, Vol. 1, Issue 6, November 2014, IJIRSTISSN: 23217308.
2. Wubshet, M. and Tadesse, S., "Stabilization of expansive soil using bagasse ash & lime", *Zede Journal, IJERT*, Vol. *32*, Issue 4, April 2014, pp.21-26. ISSN: 2278-0181.
3. Rajakumaran, K., "An Experimental analysis on Stabilization of expansive soil with Steel Slag and Fly Ash", *International Journal of Advances in Engineering & Technology*, Vol. *7*, Issue 6, Jan., 2015, p.1745, ISSN: 22311963.
4. Kinuthia, J.M. and Nidzam, R.M., "Towards zero industrial waste: Utilisation of brick dust waste in sustainable construction", *Waste Management*, Vol. *31*, Issue 8, 2013, pp.1867-1878.
5. Aashto., "Standard specifications for transportation materials and methods of sampling and testing", *IRJET*, Vol 02, Issue 5, Aug-2015, IRJET ISSN: 2395-007.
6. Amu, O. O, "Geotechnical properties of lateritic soil stabilized with sugarcane straw ash", *American Journal of Scientific and Industrial Research*, 2011.
7. Brooks, R.M., "Soil stabilization with fly ash and rice husk ash", *International Journal of Research and Reviews in Applied Sciences*, Vol. *1*, Issue 3, 2009, pp.209-217.
8. Chittaranjan, M., "Agricultural wastes as soil stabilizers", *International Journal of Earth Sciences and Engineering*, Vol 4, Issue 6, October 2011, pp 50-51.
9. Reddy, M.M., Reddy, K.R.S., Asadi, S.S., 2018. An experimental study on combination of geosynthetic material with sand for evaluation of shear strength parameters. *International Journal of Pure and Applied Mathematics*, 119 (14), pp.1779-1786.

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