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EXPERIMENTAL STUDY ON BEHAVIOR OF BLACK COTTON SOIL USING WOOD ASH AS STABILIZER

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ABSTRACT
The Black cotton soil is known as expansive type of soil which expands suddenly and start swelling when it comes in contact with moisture. Due to this property of soil the strength and other properties of soil are very poor. To improve its properties, it is necessary to stabilize the soil by different stabilizers. Stabilization is process to enhance the physical properties of soils. Stabilization can increase the shear strength of soil and control the shrink-swell properties of soil, thus improving the load bearing capacity of soil at sub-grade to support the pavement and foundation. In this project the results obtained by studying the characteristics of black cotton soil admixed with wood dust is presented. The percentage of wood dust is taken as 3.0%, 6.0%, 9.0%, and 12.0%. The addition of wood dust was found to improve the engineering properties of soil in stabilized forms specially strength, workability and compaction and California bearing ratio characteristics. Laboratory tests such as specific gravity, sieve analysis, compaction, Atterberg limits, unconfined compressive strength, and CBR were carried out different percentages of wood dust and original samples. The laboratory tests were conducted as per Indian standard specifications. The result shows that the use of wood dust increases the California bearing ratio values i.e. The strength of soil to a great extent.
KEY WORDS: Black cotton soil, Soil Stabilization, Wood dust.

1.0 INTRODUCTION

It is hard to overstate the importance of soil in construction of structures and other aspect of civil engineering practices. The foundation of a building or road is an essential part for effective transmission of load to the subsoil present beneath it. The quality of soil has large impact on type of structure and its design. Each type of soil possesses unique characteristics and plays a vital role in each distinct. Black cotton soils are weak soils possessing low shear strength. Black cotton soils occur mostly in the central and western parts and covers approximately 20% of the total area of India. They are popularly known as “Black cotton soils” because of their dark brown colour and suitability for growing cotton. Black cotton soils are very hard in dry state and possess high bearing capacity. Black cotton soils become very sticky when wet and usually are characterized by surface cracks when dry. To overcome these circumstances in the soil, it should be treated and stabilized in best way. Stabilization in a broad sense incorporates the various methods employed for modifying the properties of a soil to improve its engineering performance. Properties of soil may be altered in many ways, among which are included chemical, thermal, mechanical and other means. Wood ash is a grey material and it is the residue powder left after the combustion of wood which can be used for soil stabilization.

Objectives of Soil Stabilization

- Effective utilization of locally available soils and other suitable stabilizing agents.
- Encouraging the use of Industrial Wastages in building low cost construction.
- This method is suitable for low volume roads i.e. Village roads in low rainfall areas.
- This method involves the correctly proportioning of aggregates and soil, adequately compacted to get mechanically stable layer.
- The Basic Principles of Mechanical Stabilization are Correct Proportioning and Effective Compaction.

2.0 LITERATURE REVIEW

Stabilization can increase the shear strength of a soil and control the shrink-swell properties of a soil, thus improving the load-bearing capacity of a sub-grade to support pavements and foundations.

For the past several years researchers have recognized the use of locally available materials which are cost effective and abundantly available as by products from industrial and agricultural activities to improve the properties of expansive soil with an aim toreduce stabilization costs. Here are some of the research works done on stabilization of soil using wood ash as stabilizer.

Prof.Sharanakumar, Et al. (2020-International Research Journal of Engineering and Technology (IRJET), India), studied the effect of waste dry paint and saw dust on the properties of black cotton soil. Their main objective was to determine engineering properties of soil before and after addition of waste dry paint and saw dust. The different tests they conducted were specific gravity, sieve analysis, Atterberg limits, compaction and California bearing ratio(soaked) for natural soil as well as soil admixed with stabilizers at different percentages. Engineering properties of BCS is determined by varying percentages of dry paint waste 2%, 4%, 6% and 8% by weight of soil mass and 1.5%, 3%, 4.5% and 6% wood saw dust by weight of soil mass which gives the highest dry density less optimal moisture content.

Rakesh Verma, Et al. (2017- IJSRD - International Journal for Scientific Research & Development, India) studied the effect of lime and saw dust on the properties of black cotton soil.Their main objective was to study the behaviour of strength gain in BC soil using process of lime - Sawdust stabilization. The different tests they conducted were specific gravity, sieve analysis, atterberg limits,standard proctor test, unconfined compressive strength, California bearing ratio(both soaked and unsoaked) for natural soil as well as soil admixed with stabilizers at different percentages.

Ms. Arpita V Patel (2011-National Conference on Recent Trends in Engineering & Technology,India) studied the effect of saw dust on the properties of black cotton soil contaminated by castor oil. Their main objective was to study the behavior of strength gain in BC soil of contaminated by castor oil using process of Sawdust stabilization. The different tests they conducted were specific gravity, sieve analysis, atterberg limits,contaminated soil, standard proctor test, unconfined compressive strength(for 1,3,7,14days).

Er. Jitendra khatti, Et al. (2018-International Journal Of Advance Reasearch In Science and Engineering,India) designed the flexible pavement by black Cotton soil and 15% Kota stone slurry with wooden saw dust. Their main objective was to study the behavior of strength gain in BC soil using process of 15% Kota stone slurry with wooden saw dust stabilization. The different tests they conducted were specific gravity, sieve analysis, atterberg limits,standard proctor test, California bearing ratio(soaked) for natural soil as well as soil admixed with stabilizers at different percentages.

Rakesh Verma, Et al. (2017- (IJSRD) International Journal for Scientific Research & Development,India) studied the effect of cement and saw dust on the properties of black cotton soil. Their main objective was to study the behavior of strength gain in BC soil using process of cement-Sawdust stabilization. The different tests they conducted were sieve analysis, atterberg limits, standard proctor test, unconfined compressive strength, California bearing ratio(both soaked and unsoaked) for natural soil as well as soil admixed with stabilizers at different percentages. The Liquid limit for BC Soil samples are ranging 55-60 and Plastic Limit for the same ranges 30-40. Thus Plasticity Index of BC Soil found to the range of 20-35.

3.0 MATERIALS USED

Black Cotton Soil:

Black soil is dark, as its name suggests, and fertile with a clay- like consistency. It holds moisture well, becoming hard in dryconditions and sticky in wet conditions. The soil is composedof less than 30 percent clay, slickensides or wedge-shaped pads and cracks that open and close periodically. The mineralogy of this soil is dominated by the presence of montmorillonite which is characterized by large volume change from wet to dry seasons and vice versa. The soil which is used in this experiment is collected from the site near Gagillapur,Hyderabad,Telangana,India and the co-ordinates of point where soil sample was excavated are 17 36’20.6’’N 78 23’26.8’’E,and the soil collected at the depth of 2.0m from the ground level.

Table -1: Physical Properties of Black Cotton Soil

S.No	Properties	Value
1	Colour Black	Colour Black
2	Specific Gravity	2.60-2.75
3	Liquid Limit (%)	40-120 %
4	Maximum Dry Density (KN/CM3)	1300-1800 kg/m3
5	Optimum Moisture Content (%)	20-35 %
6	California Bearing Ratio (%)	2-4 %

Wood Ash:
Wood ash is the waste by - product produced from the incineration of wood wastes, like bark and knots. It is used traditionally by gardeners as a good source of potash for domestic gardens. Hardwoods usually produce more ash than softwoods and the bark and leaves generally produce more ash than the inner woody parts of the tree. Clean pure wood ash can is beneficial as a soil amendment replacing lime and providing many trace elements. Wood Dust is collected from carpenter shop at patancheru, Hyderabad. Then removed the other unwanted particles present in it. In this test the Sawdust which is used is of Teak (Sagwan wood) of Grade -I which is retained from the 4.75 mm sieve... Thechemical composition of wood ash is shown in Table 2.

Table 2: Chemical composition of wood ash

Constituent	Composition (%)
Silicon Dioxide	19.25
Aluminium Oxide	10.13
Calcium Oxide	35.54
Potassium Oxide	9.15
Magnesium Oxide	7.21
Ferric Oxide	2.62
Sodium Oxide	3.53
Loss On Ignition	12.28

EXPERIMENTAL INVESTIGATION

- After preparing the soil samples, basic tests such as Atterberg's limit, compaction, Unconfined Compressive Strength (UCS) and California Bearing Ratio(CBR), were carried out to determine the engineering properties of black cotton soil samples.
- Then wood ash was added to black cotton soil sample in multiples of two percentages (0%,3%,6%,9%and 12%).
- Each percentage of blended mix was taken and laboratory tests (compaction, CBR, UCC) were carried out to determine the strength behavior of the mix.
- After comparing the results on each percentage of blend,optimum percentage of addition of wood ash to be addedwas determined.
- The results are concluded suitably.

B. **Sample Preparation:**

Soil sample as received from the field is dried in the air or in sun. The clods are broken down with a wooden-mallet to hasten drying. The organic matter, like tree roots and pieces of bark were removed from the sample. They the sample is set aside in oven for drying at 110°C temperature for 24hrs. For the tests like liquid limit, plastic limit, light compaction the sample was air dried. Then wood ash was also kept in oven for maintaining the dry form of the ash. Wood ash was taken according to percentage specified and mixed with soil in dry form itself.

ANALYSIS OF DATA

Geotechnical Properties of Soil Sample

Black cotton soil (BCS) was taken and basic laboratory experiments were passed out. Soil sample was ready as stated above. These data are needed to analyze the results after addition of wood ash. Results are listed in Table 3.

Table 3: Geotechnical properties of soil sample

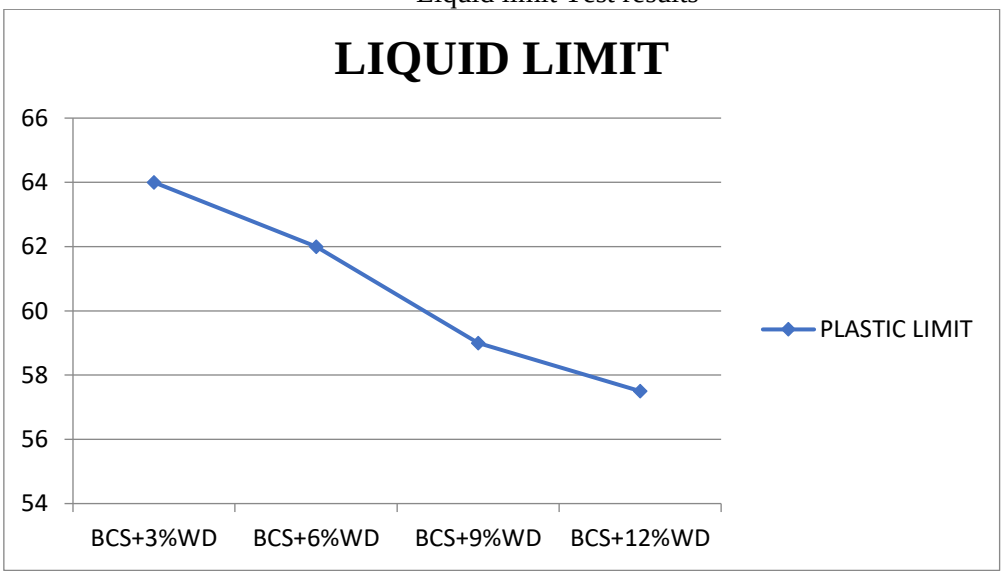
Soil Properties	Test Results
Specific Gravity	2.53
Liquid limit	66.00 %
Plastic Limit	22.72 %
plasticity index(Ip)	43.28%
optimum moisture content	25.8%
maximum dry density (G/CC)	1.461
California Bearing Ratio	3
Unconfined compressive strength	187.3

Blending with Wood Ash:

Wood ash (WA) was added to black cotton soil in following percentages: 3%, 6% , 9% and 12%. Laboratory tests were done on blended soil mix and results are tabulated in Table 4.

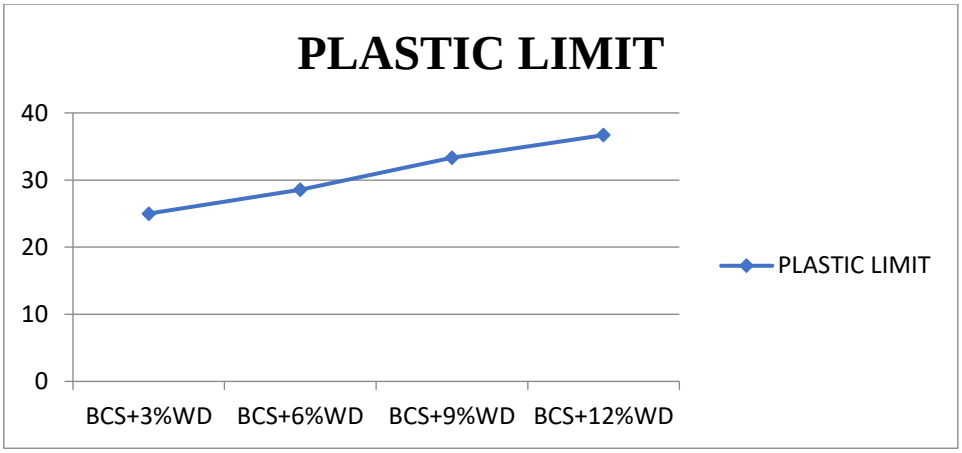
Particulars Of Test	BCS+3%WD	BCS+6%WD	BCS+9%WD	BCS+12%WD
Liquid limit	64.00	62.00 %	59.00 %	57.50 %

Liquid limit Test results



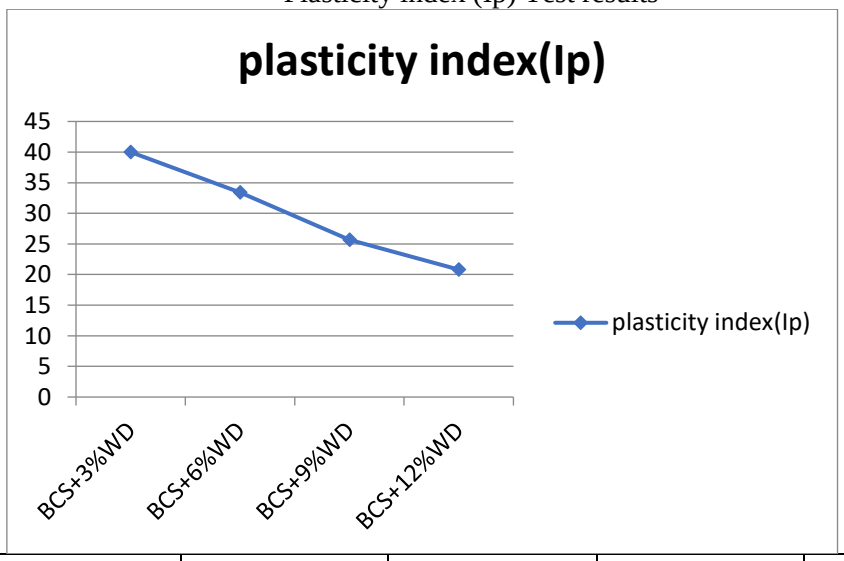
Particulars Of Test	BCS+3%WD	BCS+6%WD	BCS+9%WD	BCS+12%WD
Plastic Limit	25.0 %	28.57 %	33.33 %	36.69 %

Plastic Limit Test results



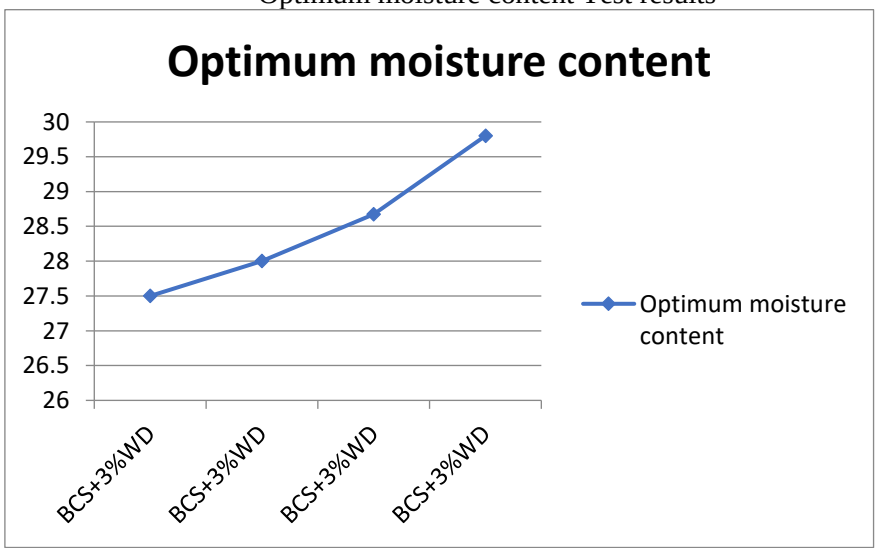
Particulars Of Test	BCS+3%WD	BCS+6%WD	BCS+9%WD	BCS+12%WD
plasticity index(Ip)	40.00%	33.43%	25.67%.	20.81%

Plasticity index (Ip) Test results



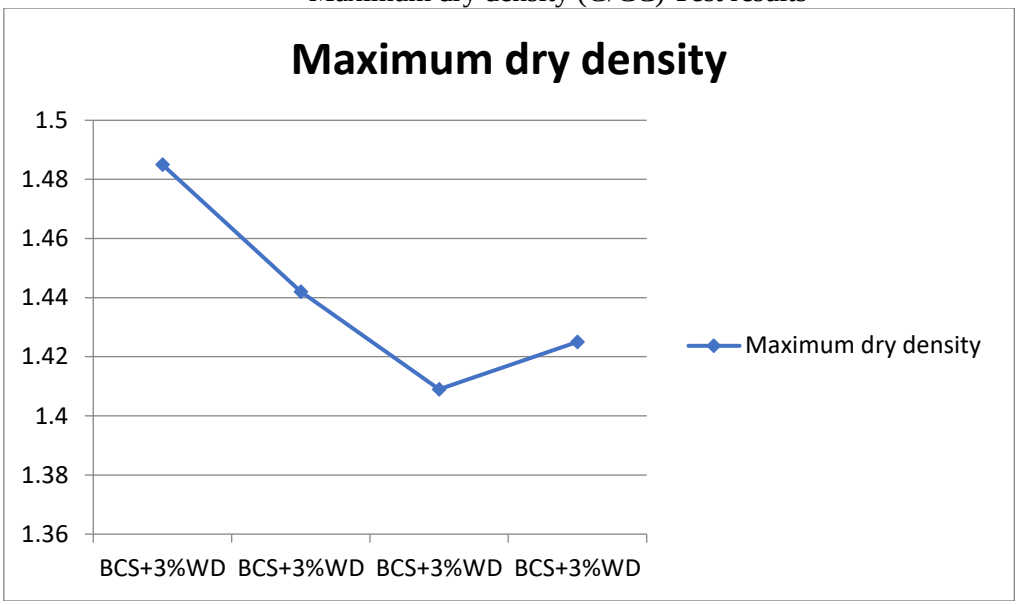
Particulars Of Test	BCS+3%WD	BCS+6%WD	BCS+9%WD	BCS+12%WD
optimum moisture content	27.5%	28.0%	28.67%	29.8

Optimum moisture content Test results



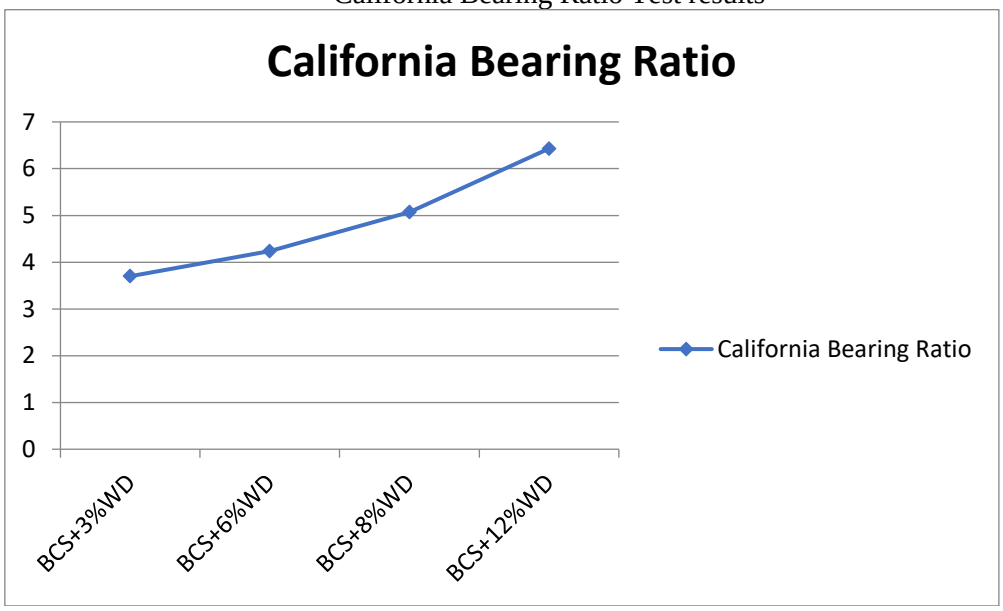
Particulars Of Test	BCS+3%WD	BCS+6%WD	BCS+9%WD	BCS+12%WD
maximum dry density (G/CC)	1.485	1.442	1.409	1.425

Maximum dry density (G/CC) Test results



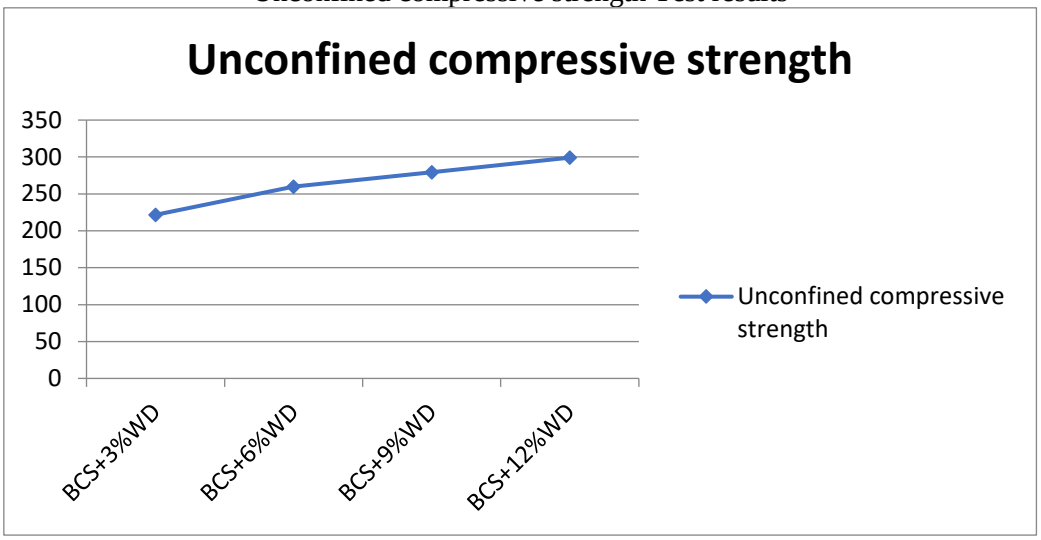
Particulars Of Test	BCS+3%WD	BCS+6%WD	BCS+9%WD	BCS+12%WD
California Bearing Ratio	3.7	4.24	5.07	6.43

California Bearing Ratio Test results



Particulars Of Test	BCS+3%WD	BCS+6%WD	BCS+9%WD	BCS+12%WD
Unconfined compressive strength UCS(qu) kn/m^2	221.6	259.9	279.5	299.1

Unconfined compressive strength Test results



CONCLUSION

- It was established that wood dust can be used as an effective stabilizer for improving the geotechnical characteristics of black cotton soil.
- The BC soil parameters are seen to have improved i.e., decreased plasticity, increased bearing strength of tee BC soil.
- Based on CBR test it was found that the soil treated with 12% of wood dust gives the optimum strength when compared with natural black cotton soil.
- Based on UCS values it was found that the soil treated with 12% of wood dust gives the optimum strength when compared with the natural black cotton soil with an increment from 1.9 kg/cm2 to 3.05 kg/cm2, and also the CBR values varies from 3% to 6.43%.

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