

ECO-FRIENDLY STABILIZATION OF BLACK COTTON SOIL

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ABSTRACT

Today stabilization of black cotton soil is very necessary to improve its properties like strength , bearing capacity ,etc. There are various types of stabilizers available for the stabilization of soil such as lime, chemical stabilizers , cement kiln dust, etc, but these stabilizers are not eco-friendly as they affect the environment in various ways. Hence it is necessary to adopt eco friendly stabilizers. Black cotton soil is fertile and very good for agriculture. Though black cotton soil are very good for agricultural purpose they are not so good for laying structures. Index properties of black cotton soil showed that the soil is poor for engineering use. Soil properties changes depending upon their constituents i.e, water content, density, bulk density, angle of friction, shear strength, etc. The properties of black cotton soil can be modified by stabilizing the soil with the use of eco friendly material like wooden ash , quarry dust, groundnut shell ash, fly ash. The experimental work is based on different percentages of these eco- friendly materials in soil on tests for Liquid limit, Plastic limit, Shrinkage limit, Standard proctor compaction test, Direct shear test, CBR test. The aim is to improve the engineering properties of black cotton soil such that the structure built on this soil can be efficiently withstand applied loads

Keyword: Black cotton soil, Eco Friendly stabilization, Quarry dust, Wood ash, Engineering Properties

I. INTRODUCTION

Soil Stabilization is the alteration of soils to enhance their physical properties. Stabilization can increase the shear strength of a soil and/or control the shrink-swell properties of a soil, thus improving the load bearing capacity of a sub-grade to support pavements and foundations. Soil stabilization can be utilized on roadways, parking areas, site development projects, airports and many other situations where sub-soils are not suitable for construction. Stabilization can be used to treat a wide range of sub-grade materials, varying from expansive clays to granular materials.

The following problems generally occur in black cotton soil.

- High Compressibility
- Swelling
- Shrinkage

- High permeability
- High plasticity

So, the stabilization is being done for the black cotton soil in this project work by using following eco-friendly materials.

1. Wooden Ash
2. Quarry Dust

1.1. Necessity Of Study

In India black cotton soil is abundantly available. But due to some unnecessary properties we can't utilize that land for other structures like roads, airport ways. Due to these properties present in black cotton soil the soil have to face the problems like high compressibility, swelling, shrinkage, high permeability. However it is important to improve the properties of black cotton soil by adding stabilizers. Addition of chemical stabilizers may harm to environment in various ways. Other than that it may increase the cost of project. Hence in all ways eco-friendly stabilizers are necessary for decreasing the cost factor and they are environment friendly. Also the threat of disposing the industrial wastes like quarry dust and wood ash will not solve until the practical steps are not initiated at the ground level. It is beneficial to use eco-friendly stabilizers in the alternate of chemical stabilizers.

Addition of eco-friendly stabilizers would not only increase the bearing capacity of roadways but also provide a beneficial way of disposal of a large amount of industrial waste such as quarry dust and wood ash. They do not have significant use in any productive work and have disposal problem also.

1.2. Literature Review

P.Indiramma and Dr.Ch.Sudharani [2016] has carried out experimental work on expansive soil and shows that Liquid Limit, Plastic Limit and Plasticity Index, differential free swell index are on decreasing with addition of quarry dust in different percentages. The Maximum Dry Density (MDD) is on increasing and Optimum Moisture Content (OMC) is decreasing with increase in percentage of Quarry Dust. The Unconfined Compressive Strength (UCS) is increasing with increase in percentage of Quarry Dust.

In study of potential material- wood ash (WA) to stabilize problematic clay soil sample was evaluated by Roshni R et al [2015], The test may result maximum strength of the soil samples when treated with 12% wood ash. The strength gained by the soil samples depends upon the percentage proportion of the stabilizers added as well as time allowed for curing. This paper concludes that 12% WA was found to be the maximum percentage proportion of stabilizers which yielded maximum strength in the soil sample. The strength development is due to the reaction between WA and soil minerals, resulting in the formation of cementitious compounds.

H. Venkateswarlu, et al [2015] has carried study on black cotton soil. In their work black cotton soil is treated with different percentages of quarry dust. Liquid limit of Expansive soil was found to decrease from 89% to 75.5% with the increase in percentage of Quarry Dust. On the other hand Plastic Limit of expansive soil decreases from 41.26% to 36%. This paper concluded that the California Bearing Ratio value of expansive soil was found to increase from 3.2 to 8.24 under unsoaked condition with the increase in percentage of Quarry Dust up to 10%. It was found that the MDD attained at 10% Quarry Dust and OMC goes on decreasing with increase in percentage of Quarry Dust. From the above experimental analysis it is found that Quarry Dust up to 10% can

be utilized for strengthening the expansive soil with a substantial save in cost of construction. Many researchers have studied the use of eco-friendly stabilizers in black cotton soil. In this test we include various important tests such as shear test as well as CBR test for quarry dust and wood ash, which result into the effective comparison of the strength of black cotton soil. Comparison of these two suggests the proper choice of stabilizers.

1.3. Objectives Of Study

After identification of problem and setting the objective of research, following specific objectives are framed to study the utilization of quarry dust and wood ash for effective stabilization of black cotton soil:

1. To determine the relevant index and engineering properties of black cotton soil.
2. To cast various trial mixes with varying percentages of quarry dust and wood ash in soil samples.
3. To compare the trail mixes with conventional soil samples and with each other.
4. To select the optimum percentage of stabilizers to be mixed with soil to produce maximum strength.
5. To comment on the suitability and limitations of quarry dust and wood ash for effective soil stabilization.

II. RESEARCH METHODOLOGY

The research methodology for present study has adopted various tests to investigate the results on soil. The quarry dust is collected from stone crusher, Malkapur and wood ash is collected from villages near Jalgaon and used for testing. The various tests conducted on soil samples and stabilizers mixed soil samples were as follows:

Sr.no.	Test	Apparatus used	Reference
1	Specific Gravity Test	Pycnometer	IS : 2720-Part 3-1980
2	Liquid Limit Test	Casagrande's Appratus	IS : 2720-Part 5-1985
3	Plastic Limit Test	Oven	IS : 2720-Part 5-1985
4	Shrinkage Limit Test	Shrinkage Dish	IS : 2720-Part 6-1972
5	Standard Proctor Test	Cylindrical Mould,Rammer	IS : 2720-Part 7-1980
6	California Bearing Ratio	CBR test Appratus	IS : 2720-Part 16-1979
7	Shear Test	Direct Shear Test	IS : 2720-Part 13-1986

III. RESULTS AND DISCUSSIONS

3.1. Specific Gravity

The variation of Specific Gravity to the stabilizers is as follows:

Sr no.	% of stabilizer	Result	
		wood ash	quarry dust
1	Pure soil	2.36	2.36
2	5% replacement	2.34	2.4
3	10% replacement	2.32	2.48

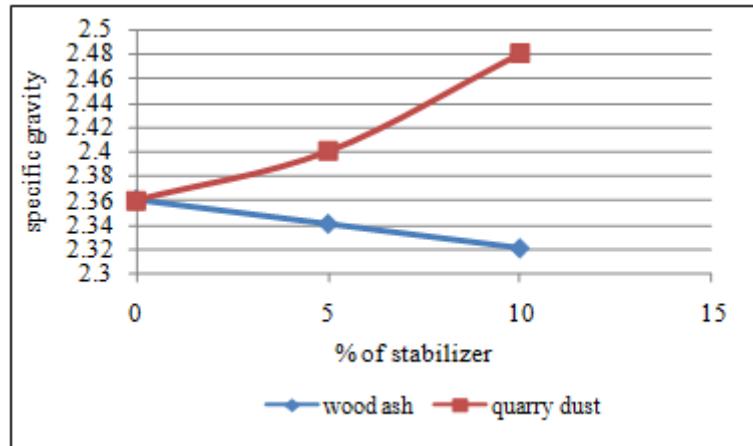


Fig 3.1 Results Of Specific Gravity

Comment:-Specific Gravity of soil increases with increase in percentage of quarry dust and it decreases with increase in percentage of wood ash.

3.2. Liquid Limit Test

The variation of Liquid limit to the stabilizers is as follows:

Sr no.	% of stabilizer	Result	
		wood ash	quarry dust
.			
1	Pure soil	60	60
2	5% replacement	52.38	50
3	10% replacement	44.2	40.9

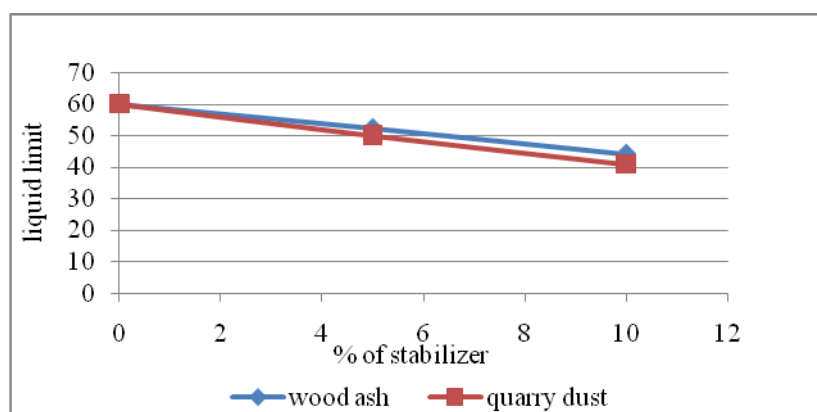


Fig 3.2 Results Of Liquid Limit

Comment:-Liquid limit of soil decreases with increase in percentage of quarry dust and wood ash.

3.3. Plastic Limit Test

The variation of plastic limit to the stabilizers is as follows:

Sr no.	% of stabilizer	Result	
		wood ash	quarry dust
1	Pure soil	28	28
2	5% replacement	25.8	26
3	10% replacement	22.9	23.9

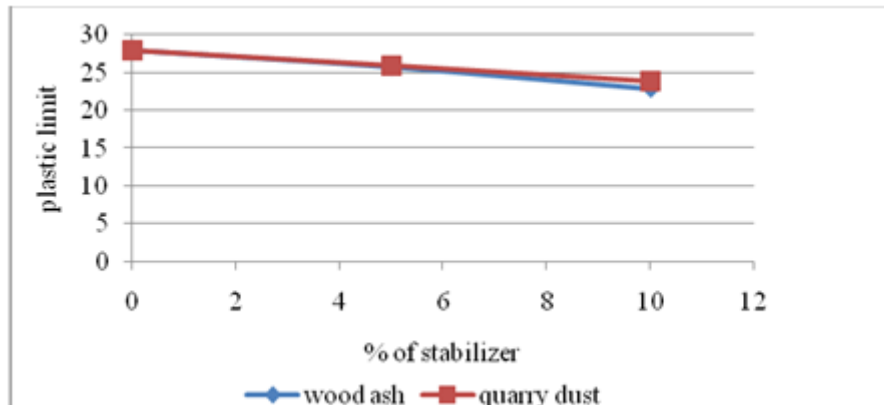


Fig 3.3 Results Of Plastic Limit

Comment:- It is observed that as the percentage of admixture increases, the plastic limit decrease

3.4. Shrinkage Limit Test

The variations in the results of shrinkage limit are as shown in graph:

Sr no.	% of stabilizer	Result	
		wood ash	quarry dust
1	Pure soil	40	40
2	5% replacement	34.2	38.5
3	10% replacement	30.1	36.1

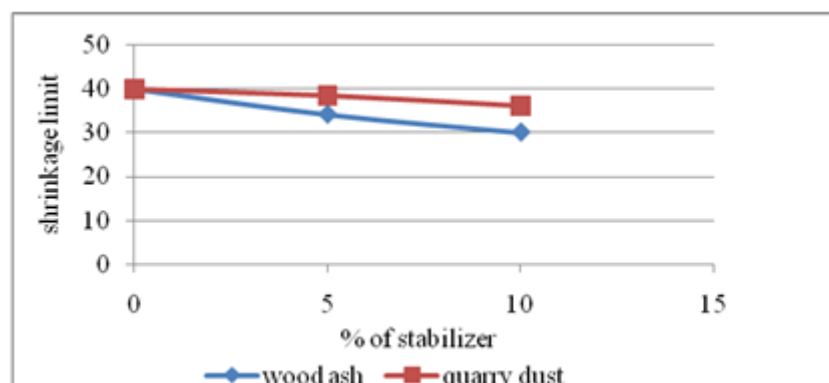


Fig 3.4 Result Of Shrinkage Limit

Comment:- Shrinkage limit of soil decreases with increase in percentage of quarry dust and wood ash.

3.5. STANDARD PROCTOR TEST

3.5.1. Optimum Moisture Content

Compaction characteristics of the soil are assessed by determining the optimum moisture content and maximum dry density. These are the control parameters governing the soil behavior. The percentage variation of the optimum moisture content to the stabilizers is given in table. 3.5.1

Sr No.	% of stabilizer	Result	
		quarry dust	wood ash
1	Pure soil	33	33
2	5% replacement	32	31
3	10% replacement	25	26

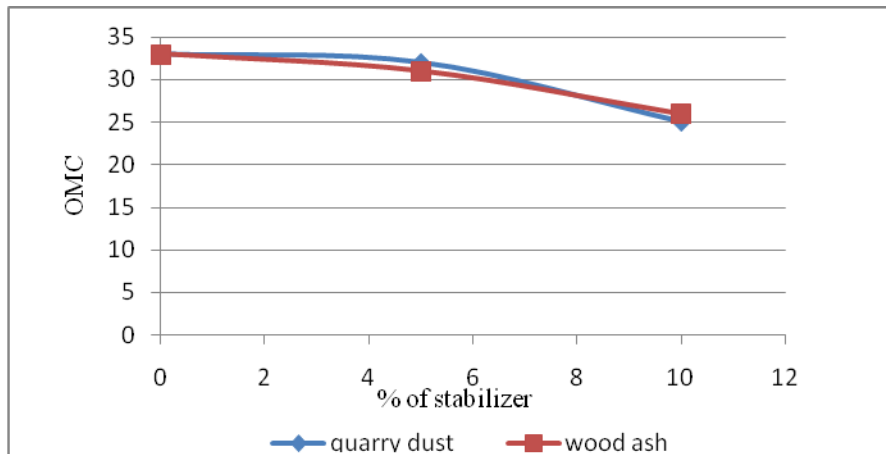


Fig 3.5.1 Results Of OMC

Comment :-As the percentage of stabilizers increases, optimum moisture content decreases.

3.5.2. Dry Density

The variation of maximum dry density with the percentages of stabilizers is as follows:

Sr No.	% of stabilizer	Result	
		quarry dust	wood ash
1	Pure soil	13.62	13.62
2	5% replacement	14.23	13.9
3	10% replacement	15.02	15

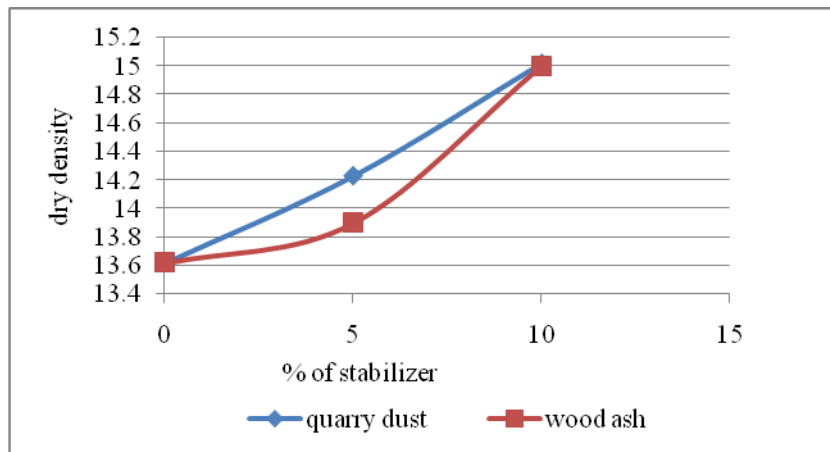


Fig 3.5.2 Results Of Dry Density

Comment:-It is observed that as the percentage of stabilizers increases, maximum dry density increases. Dry density of quarry dust is greater than that of wood ash.

3.6. California Bearing Ratio (Unsoaked)

Sr No.	Specification	Result	
		quarry dust	wood ash
1	Pure soil	0.311	0.311
2	5% replacement	0.3288	0.317
3	10% replacement	0.335	0.322

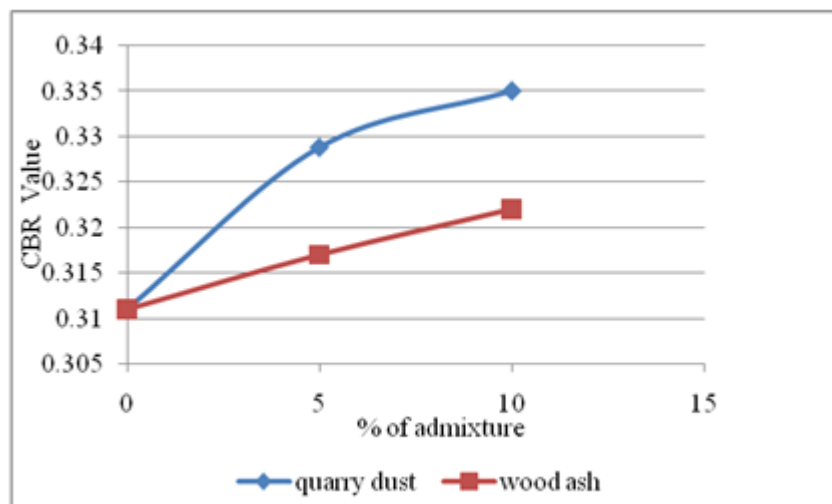


Fig 3.6 Results Of CBR Value

Comment:-The California Bearing Ratio value of black cotton soil was found to increase under unsoaked condition with the increase in percentage of Quarry Dust and wood ash up to 10 %.According to graph CBR value of quarry dust is greater than wood ash.

3.7. Direct Shear Test

Variation of cohesion and angle of shearing resistance:

Sr no.	% of stabilizer	Result	
		Wood ash	Quarry Dust
1	Pure soil	58.13	58.13
2	5% replacement	44.23	45.3
3	10% replacement	30.2	31.4

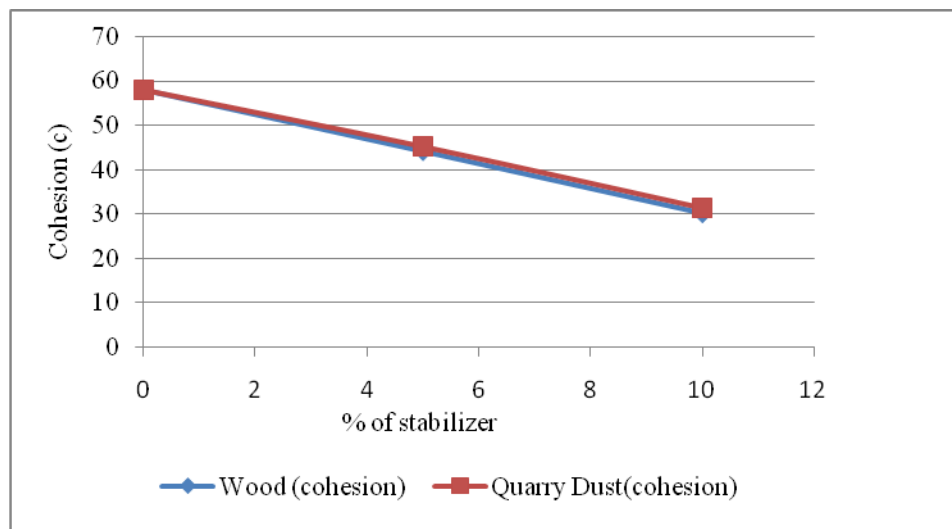


Fig 3.7.1 Results Of Shear Test

Comment: Cohesion of the black cotton soil is decreased after adding stabilizers into it, which is beneficial to its strength.

Sr. no.	% of stabilizer	Result	
		wood (φ)	Quarry Dust(φ)
1	Pure soil	27	27
2	5% replacement	27.09	27.29
3	10% replacement	27.15	27.6

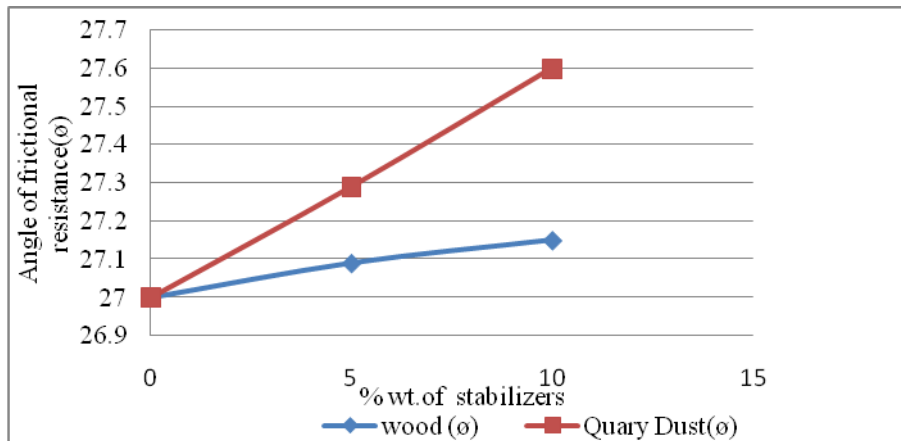


Fig 3.7.2 Results Of Shear Test

Comment: Frictional angle of black cotton soil is increased by increasing the percentage of stabilizers into it, which shows increased stabilization of soil.

III . CONCLUSION

3.1. Advantages

- Both the stabilizers wood ash and quarry dust are easily available.
- They are not used in any other product hence their cost is very low.
- As these stabilizers are waste products, the threat of disposing them is done in very efficient way.
- The cost of structure becomes cheap, as the stabilizers are available in very low cost.

3.2. Limitations

The main limitation of using wood ash in stabilization of black cotton soil as follows:

- The burning of wood ash creates air pollution and also health hazards.

3.3. Conclusion

From this research paper, we concluded that,

- Wood ash and quarry dust are the industrial wastes which can be efficiently used as the eco-friendly stabilizers.
- According to the various tests conducted on black cotton soil with and without stabilizers, the quarry dust with 10% weight of soil sample improves all the soil properties as compared to the use of 10% wood ash as a stabilizer.
- Effective, eco-friendly and economical soil stabilization.

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