EFFECT OF JUTE ON PROPERTIES OF LIME AND BAGASSE ASH STABILIZED BLACK SOIL

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Abstract - *Stabilization is an important aspect in case of black soil as it contains large amount of montmorillonite. This clay mineral is highly responsible for shrinkage, swelling and settlement which cause inconvenience in construction. Hence, it is important to stabilize the soil to make it compatible for construction. In this paper, stabilization is done using lime and bagasse ash in various percentages like 2%, 4%, 6% and 3%, 6%, 9% respectively. The laboratory tests have done for atterberg limits, standard proctor and unconfined compression test for untreated black soil, lime treated black soil, bagasse treated black soil and combination of both lime and bagasse ash treated black soil. California Bearing Ratio test is done for untreated and optimum of combination using jute fiber in order to increase the bearing ratio to a considerable extent. It is found that liquid limit of black soil decreased from 58.8% to 44% , plasticity index decreased from 30.2% to 1.79% ,optimum moisture content increases from 20% to 23.63% and maximum dry density decreases from1.698 to 1.597 g/cc, unconfined compressive strength increases from 96 kN/m² to 338.28 kN/m² at optimum mix proportion of 4:6 (4% lime,6% bagasse ash).California Bearing Ratio increased when jute fiber is fixed at a depth of D/3 below footing and bitumen is coated to prevent the jute fiber from decaying.*

***Key Words*: Black soil, lime, bagasse ash, jute, bitumen.**

1. INTRODUCTION

Generally the black soil is found in central, western, and southern states of India. This soil has low bearing capacity. And also due to variation of moisture content in black soil swelling and shrinkage will occur. It causes the differential movement, resulting in severe damage to the foundations. The expansive soil losses its strength in wet condition. The process of improving the properties of weak soil by using various stabilizing agents is called soil stabilization. It makes the soils more stable by reducing permeability and compressibility. It increases the shear strength and the bearing capacity of the soil. Lime and bagasse ash stabilization is an economic way to stabilize the soil which helps to improve the strength, resist fracture, fatigue and permanent deformation. It gives resistance to damaging effects of moisture. When the stabilized soil is incorporated with jute fiber, it shows further increase in the bearing capacity of soil.

2. MATERIALS

2.1 Lime: Lime can be in the form of Quicklime, hydrated lime. If quicklime is used, it immediately hydrates and releases heat. Soils are dried, because water present in the soil participates in this reaction, and because the heat generated can evaporate additional moisture. If hydrated lime or hydrated lime slurry is used drying occurs only through the chemical changes in the soil that reduce its capacity to hold water.

2.2 Bagasse Ash: Bagasse is a fibrous material obtained from sugarcane plant after the extraction of sugarcane juice. Sugar factory produces 30% bagasse for each lot of crushed sugarcane, when this bagasse is burnt the resultant ash is bagasse ash. It is a pozzolanic material which is very rich in oxides of silica, aluminum and hence it is used as a stabilizing material for stabilizing black soil.

2.3 Jute: Jute is the most important products with a large-scale application. It prevents soil erosion control, consolidation of vegetation, agro-mulching, reinforcement, and protection of riverbanks & embankments, land reclamation and in road pavement construction.

3. GENERAL PROPERTIES OF BLACK SOIL

S.NO	PROPERTIES	VALUE
1	Liquid Limit	58.87%
2	Plastic Limit	28.6%
3	Shrinkage Limit	9.21%
4	Max. Dry Density	1.69g/cm³
5	OMC	20%
6	UCS	96kN/m²
7	California Bearing Ratio	2.6%

Table-1 General Properties

4 EXPERIMENTS

4.1 Mix Proportions

Black Soil + 2% Lime + 3% BA
Black Soil + 2% Lime + 6% BA
Black Soil + 2% Lime + 9% BA
Black Soil + 4% Lime + 3% BA
Black Soil + 4% Lime + 6% BA
Black Soil + 4% Lime + 9% BA
Black Soil + 6% Lime + 3% BA
Black Soil + 6% Lime + 6% BA
Black Soil + 6% Lime + 9% BA

4.2 Liquid Limit

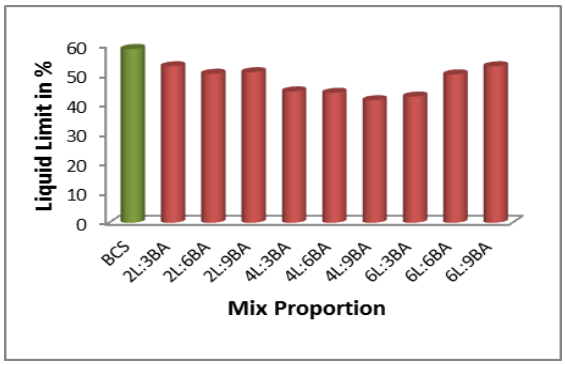
It is the minimum water content at which the soil is still in liquid state but has resistance against flowing.

Figure - 1 Liquid limit

S.No.		Lime in %	Bagasse Ash in %	Liquid Limit in %
1	Black Soil	-	-	58.8
2		2	3	53
3		2	6	50.46
4		2	9	51
5		4	3	44.5
6		4	6	44
7		4	9	41.5
8		6	3	42.75
9		6	6	50.25
10		6	9	53

Table - 2 Comparison on liquid limit

4.3 EFFECT ON LIQUID LIMIT



Graph - 1 Liquid limit

4.4 PLASTIC LIMIT

It is the minimum water content at which the soil can be moulded into any shape without deformation.

Plasticity index is the difference between liquid limit and plastic limit.

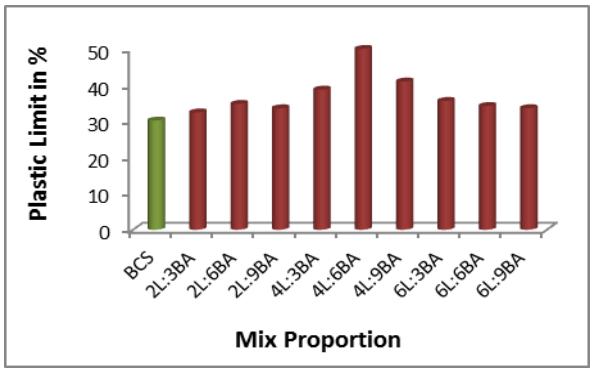
Plasticity index = liquid limit – plastic limit

Figure - 2 Plastic limit

S.NO.		Lime in %	Bagasse ash in %	Plastic limit in %	Plasticity index in %
1	Black soil	-	-	28.6	30.2
2		2	3	32.44	20.56
3		2	6	34.78	15.68
4		2	9	36.56	14.40
5		4	3	38.73	5.77
6		4	6	42.21	1.79
7		4	9	40.98	0.52
8		6	3	35.61	7.14
9		6	6	34.21	16.54
10		6	9	33.62	19.38

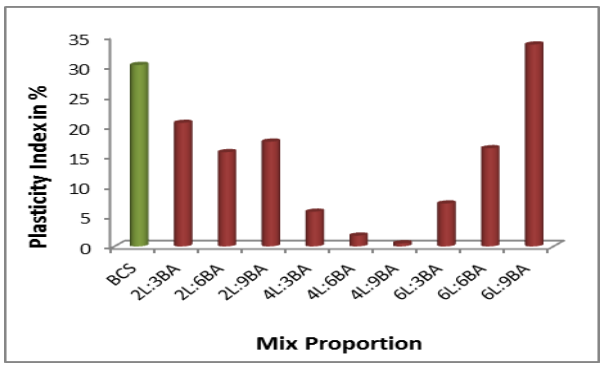
Table - 3 Comparison on plastic limit and plasticity index

4.5 EFFECT ON PLASTIC LIMIT



Graph - 2 Plastic limit

4.6 EFFECT ON PLASTICITY INDEX

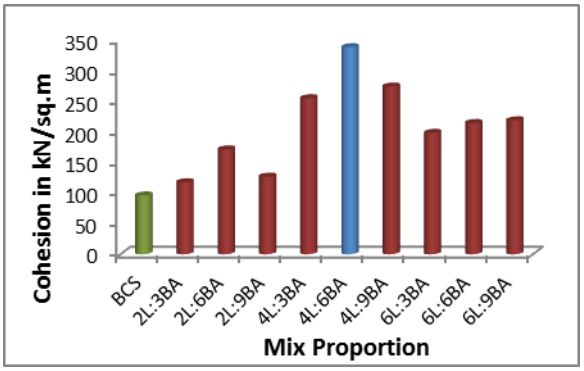


Graph - 3 Plasticity index

4.7 UNCONFINED COMPRESSION TEST

Figure - 3 UCS testing apparatus

4.8 EFFECT ON COHESION



Graph - 4 UCS

4.9 MOHR'S CIRCLE FOR OPTIMUM MIX

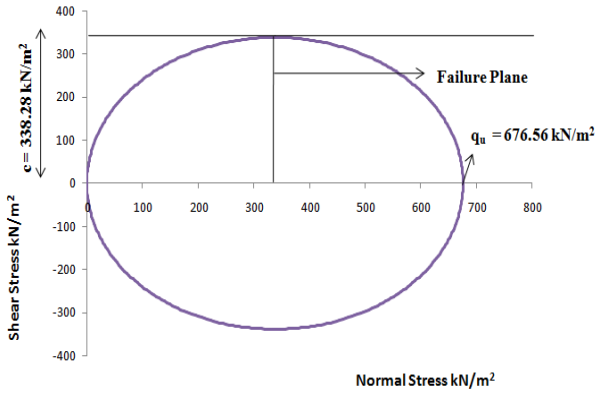


Figure - 4 Mohr's circle

4.10 STANDARD PROCTOR TEST

Compaction is the densification of soil which subsequently reduces the voids in the soil. A curve is drawn between water content and dry density to obtain the maximum dry density and the optimum water content. The dry density is maximum at the OMC.

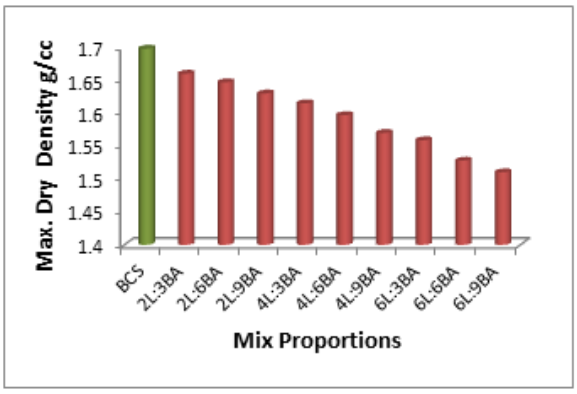
It is observed that with the initial addition of water the dry density starts to increase. At a certain point it reaches its maximum. This point is known as the maximum dry density and the corresponding moisture content is the OMC. With the further addition of water the dry density starts to decrease.

Figure - 5 Standard proctor apparatus

S.No		Lime in %	Bagasse ash in %	OMC (%)	Max.Dry Density (g/cc)
1	Black soil	-	-	20.00	1.698
2		2	3	21.50	1.660
3		2	6	21.80	1.647
4		2	9	22.00	1.630
5		4	3	23.09	1.615
6		4	6	23.63	1.597
7		4	9	24.49	1.570
8		6	3	25.36	1.559
9		6	6	26.45	1.528
10		6	9	27.13	1.510

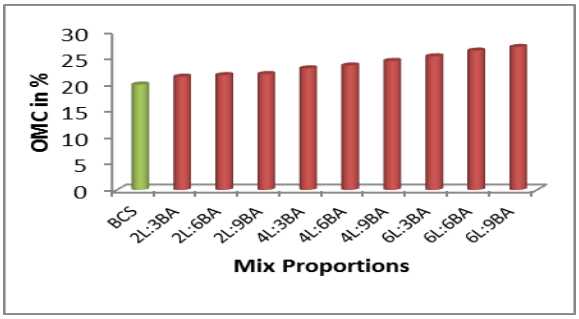
Table - 4 Comparison of Max. dry density and OMC

4.11 EFFECT ON MAXIMUM DRY DENSITY



Graph - 5 Effect on maximum dry density

4.12 EFFECT ON OMC



Graph - 6 Effect on OMC

4.13 CALIFORNIA BEARING RATIO TEST

It is used to determine the CBR value of the soil. It is the ratio of test unit load to the standard unit load.

Penetration (mm)	2.5	5	7.5
Standard unit load (kg/cm^2)	1370	2055	2630

Table - 5 Standard unit load

Figure - 6 CBR apparatus

S.NO	DESCRIPTION	CBR RATIO in %
1	Untreated	2.6
2	Optimum treated mix 4:6	6.7
3	Optimum mix + bitumen coated jute at depth D/2	10.1
4	Optimum mix + bitumen coated jute at depth D/3	11.26
5	Optimum mix + bitumen coated jute at depth D/5	8.34

Table - 6 CBR value

5. RESULT AND DISCUSSION

From the series of test it is found that the properties of black soil have been enhanced by the addition of lime and bagasse ash incorporated with jute fiber. The following were the results obtained from the test.

1. It is observed that the liquid limit of the soil decreased from 58.8% to 41.5%.

2. The plastic limit of the stabilized soil increases from 28.6% to 42.21% whereas the plasticity index becomes negligible.

3. It was observed that with the addition of lime and bagasse ash the maximum dry density decreases from 1.698g/cc to 1.510g/cc and the optimum moisture content decreases from 20.00% to 27.13%.

4. The unconfined compression strength of the soil increases from 96 kN/m^2 to 338.28 kN/m^2 with the addition of 4% lime and 6% bagasse ash. Hence this proportion is considered as the optimum mix proportion.

5. The CBR test result of the untreated soil is found out to be 2.6%.The CBR value increases to 11.23% when the soil is treated with lime and bagasse ash incorporated with jute fiber. The jute is coated with bitumen in order to prevent it from decomposition.

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