IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Experimental Study On Soil Stabilization By Using Sugarcane Pressmud

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Abstract: In This Paper Soil Stabilization is one of the important requirements before construction of any road pavement specially in sub grade, it is a technique which improves the stability of weak soils. stabilization is carried out by using various binders which are mostly waste materials. Many times, the sub grade soil does not have good engineering properties so binders act as a stabilizing agent for improving the properties of soil. In the project the waste product used is Sugarcane press mud. Sugarcane press mud is compressed sugar industry waste produced during filtration of cane juice which is contains micro nutrients (calcium, sulphur, magnesium and Iron) and macro- nutrients (nitrogen, phosphorus and potash). Sugarcane press mud is a sustainable, easily available and low-cost soil stabilizer used for improving soil properties. For the purpose of soil stabilization virgin soil is mixed with the stabilizing agent (i.e., press mud) by using water. To investigate the resulting improvement in soil strength is carried out by using California bearing ratio, Atterberg's limit test, Un-confined compressive test, Specific gravity test, Sieve Analysis, Modified proctor test carried out by addition of 5%, 7.5%, 10%, 12.5%, 15% of press mud to soil samples. The results obtained were satisfactory for improving the soil strength at 15% addition of sludge. Keywords: Lime, Bamboo Fibre, California Bearing Ratio, Unconfined Compressive strength, Modified Proctor, Black Cotton Soil, Pavement design.

I. INTRODUCTION

The soils which show volumetric changes due to changes in their moisture content are referred to as swelling soils. Some partially saturated clayey soils are very sensitive to variations in water content and show excessive volume changes. Such soils, when they increase in volume because of an increase in their water contents, are classified as expansive soils. Problem of expansive soils has appeared as cracking and break-up of pavements, railways, highway embankments, roadways, building foundations, slab on-grade members and, channel and reservoir linings, irrigation systems, water lines, sewer lines. It is reported that damage to the structures due to expansive soils has been the costliest natural hazard in some countries. In the United States damage caused by expansive clays exceeds the combined average annual damage from floods, hurricanes, earthquakes, and tornadoes. Documented evidence of the problems associated with expansive clays is worldwide, having occurred in such countries as the United States, China, Australia, India, Canada, and regions in Europe.

It is reasonable that studies on the problem of expansive soils become more important day by day if the durative deficit of world resources and economy is taken into consideration. When geotechnical engineers are faced with expansive soils, the engineering properties of those soils may need to be improved to make them

suitable for construction. A substantial literature has concluded this severity an extent of damage inflicted by soil deposits of swelling nature, to various structures, throughout the world. The loss caused due to damaged structures proved the need for more reliable investigation, of such soils and necessary methods to eliminate or reduce the effect of soil volume change.

Additives, including lime, fly ash, Portland cement, saw dust and more recently synthetics are available that will lessen these problems when mixed in the proper amounts with problem soils. These additives may be used separately or in combination and each has construction issues related to its performance Black cotton soil (BC Soil) represents a well-known category of problematic from civil engineering point of view.

Figure.1 Black Cotton Soil

They exhibit large volumetric changes shrinkage and swelling behaviour if the moisture content changed. Due to this nature this type of soil is susceptible to damage to the structures and pavements founded on it. In India expansive soils cover about $0.8X10^6$ km² area approximately 20% of surface area. Structure founded in areas with soft or weak soil have need for improvement of soil properties by using additives. Soil stabilization techniques are used to improve shear strength, CBR, reducing expansive characteristics, etc. Silica fume also referred as micro-silica is a product resulting reduction of high purity quartz with coal in an electric arc furnace in the manufacture of silicon or ferrosilicon alloy. Silica fume rises as an oxidized vapour. It cools, condenses and is collected. It is fine grey coloured powder sometime similar to Portland cement or some flashes. Condensed silica fume is essentially silicon-dioxide (more than 90%) in non-crystalline form. Since it is an air borne material line flash it has spherical shape. It is extremely fine with a particle size less than 0.1 micron and specific surface area of about 20,000m²/kg. Silica fume is used as an artificial pozzolanic admixture in concrete. As far as the production of silica fume is concerned nearly 100,000 tons of micro silica is produced each year worldwide. Iron also has a large amount of micro silica production. Steel Authority of India has provided necessary facilities to produced more than 3000 tons of Silica fume annually. Many waste materials are used to modify the characteristics of soft soils. Traditionally the soils are stabilized by lime, cement, etc. In recent year the uses of waste materials like flash, plastic, rice- husk ash, slag, etc. for soil stabilization is gaining importance. In this study attempts are made to find the influences of silica fume on engineering characteristics of black cotton soil. Bamboo is a naturally occurring composite material which grows abundantly in most of the tropical countries. Bamboo has a very long history with human kind. Bamboo is also one of the oldest building materials used by human kind. It has been used widely for household products and extended to industrial applications due to advances in processing technology. It has been used widely for household products and extended to industrial applications due to advances in processing technology.

A. The Effect of Sugarcane Pressmud Stabilization on Properties of Black Cotton Soil

Black soils have wide development in Bombay, western part of Madhya Pradesh, part of Gujarat, and in some parts of Madras. In Bombay, large area is occupied by soils derived from the Deccan trap. Black Cotton soils absorb water heavily, swell, become soft and lose strength. These soils are easily compressible when wet and possesses a tendency to heave during wet condition. Black Cotton soils shrink in volume and develop cracks

during summer. They are characterized by extreme hardness and cracks when dry. These properties make them poor foundation soils and earth construction material. The stability and performance of the pavements are greatly influenced by the sub grade and embankment as they serve as foundations for pavements. For developing a good and durable road network in black cotton soil areas, the nature of soils shall be properly understood. On such soils suitable construction practices and sophisticated methods of design need to be adopted.

B.Sugarcane Pressmud Stabilization

Soil stabilization is a collective term for any physical, chemical, or biological method, or any combination of such methods that may be used to improve certain properties of a natural soil to make it serve adequately an intended engineering purpose. It is the process of blending and mixing materials with a soil to improve certain properties of the soil.The process may include the blending of soils to achieve a desired gradation or the mixing of commercially available additives that may alter the gradation, texture or plasticity, or act as a binder for cementation of the soil. The main benefits of using Sugarcane Pressmud to stabilize clays are improved workability, increased strength, and volume stability. Workability is improved because flocculation makes the clay more friable; this assists combination for effective mixing and compaction. Sugarcane Pressmud increases the optimum water content for compaction, which is an advantage when dealing with wet soil. The compaction curve for lime-treated clay is generally flatter, which makes moisture control less critical and reduces the variability of the density produced. Sugarcane Pressmud increases the strength of clayey soil. Related to strength is improved durability under traffic or resistance to the action of water, wind, and freeze-thaw cycles. The shrinkage and swell characteristics of soil are reduced markedly. The Sugarcane Pressmud stabilized layer forms a water-resistant barrier by impeding penetration of gravity water from above and capillary moisture from below. Sugarcane Pressmud stabilization of clay soils is achieved in the field by shallow/surface stabilization or deep stabilization methods. Shallow stabilization using Pressmud is achieved by mechanical mixing of Sugarcane Pressmud and black cotton soil, spreading the mix and then compacting it. A detailed study of the exact effects of Sugarcane Pressmud addition to the properties of black cotton soil is needed so that it can be used as a reference in future construction works in such soils. Black soil specimens from the Latur district of Maharashtra were taken to study the effects of addition of lime on the properties of the soil.

Figure 2 Sugarcane Pressmud

II. MATERIAL & PROPERTIES

A. Material Used for Stabilization

1) Black Cotton Soil

- Black cotton soil is not suitable for the construction work because its volumetric changes.
- Therefore, it is necessary to improve the properties of black cotton soil to avoid damage to the structures.
- Collecting soil sample from site which is situated at Wagholi, Pune.

2. Sugarcane Pressmud

- Energy generation: Dry pressmud contains a higher percentage of combustibles, which can be exploited for energy generation.
- Moisture content: Fresh pressmud is 76% moisture, but can decrease to 59% after being stored in open space.
- Biogas: Contains about 5–15% sugar, making it a good source of biogas

B. Black Cotton Soil Engineering Properties

Table 1. Black Cotton Soil Properties

Properties of the soil	**Black Cotton soil**
Color	Black
Specific Gravity	2.17
GrainsSizesDistribution	Well graded
Atterberg's Limit Liquids Limit in (%) Plastics Limit in (%) PlasticityaIndex in (%)	 27.28 36.11 38.54
Compactions Characteristics. MaximumsDrysDensity (g/cc) OptimumsMoisturesContent (%)	 1.56 15
CBR VALUE in (%)	4.45

A. Chemical Composition Black Cotton

Table 1 Chemical Composition Black Cotton

Mineral	Value
Alumina	10%
Iron Oxide	(9-10%)
Lime and Magnesium Carbonates	(6-8%)
Potash	<0.5%
Phosphate, Nitrogen, Humus	Low

Objectives: -

- To study the engineering properties or Index properties, compaction properties and CBR of expensive soil mixing with various percentage of Sugarcane pressmud.
- To find out optimum percentage dosage and also comparing change in Engineering properties with natural expensive soil.

III. METHODOLOGY

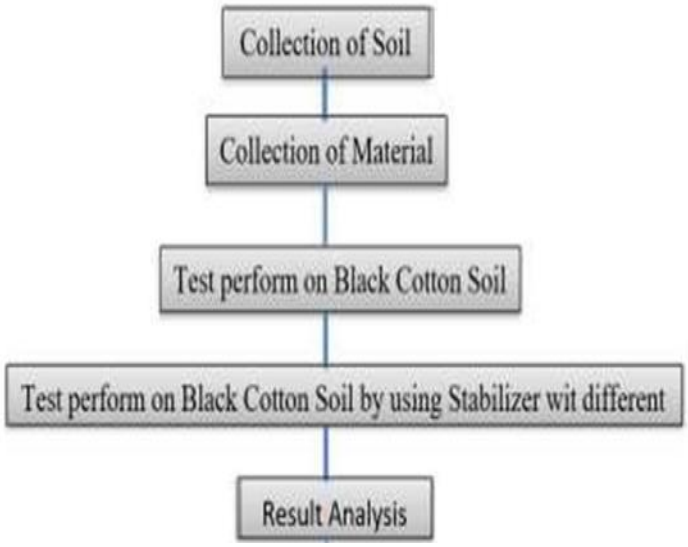


Figure.2 Methodology Flowchart

The Highway Research Board (HRB) classification of the soil strata like black cotton soil and are done using suitable sampling technique such as Core Cutter Method. To determine the characteristics like Grading by Sieve Analysis, Atterberg Limits i.e. Liquid limit using Casagrande Method, Plastic limit by rolling the sample to 3mm diameter thread, Shrinkage limit using Shrinkage apparatus, Optimum Moisture Content and Maximum Dry Density using Standard Proctor Test and also California Bearing Ratio by conches determination of the properties such as liquid limit, plastic limit, shrinkage limit, optimum moisture content, maximum dry density, CBR value and shear strength for different concentration of lime and bamboo fibre with black cotton soil as IS:2720. The pavement thickness design will be done using pavement design catalogues published by IRC SP:20-2002. The estimation for the road is done by considering the item such as Jungle Cutting, Earthwork Excavation for Roadway and Drains, compacting and grading etc., as per SR 2020-21, PWD circle and suggestion of specification for the mixture of Bamboo fibres as Geo Synthetic material for stabilization. during four days soaked CBR Test and Shear using Unconfined Compression Test. The different tests were conducted in order to determine the different characteristics and properties of the soil. The procedure of each of the tests have been explained below.

A. Tests
Performed on Soil

1. Sieve analysis on Black cotton soil.
2. Specific gravity by pycnometer.
3. Free swell Index Test
4. Atterberg limit:
    a. Liquid Limit
    b. Plastic Limit
    c. Shrinkage limit
5. Modified proctor test
6. California bearing ratio test

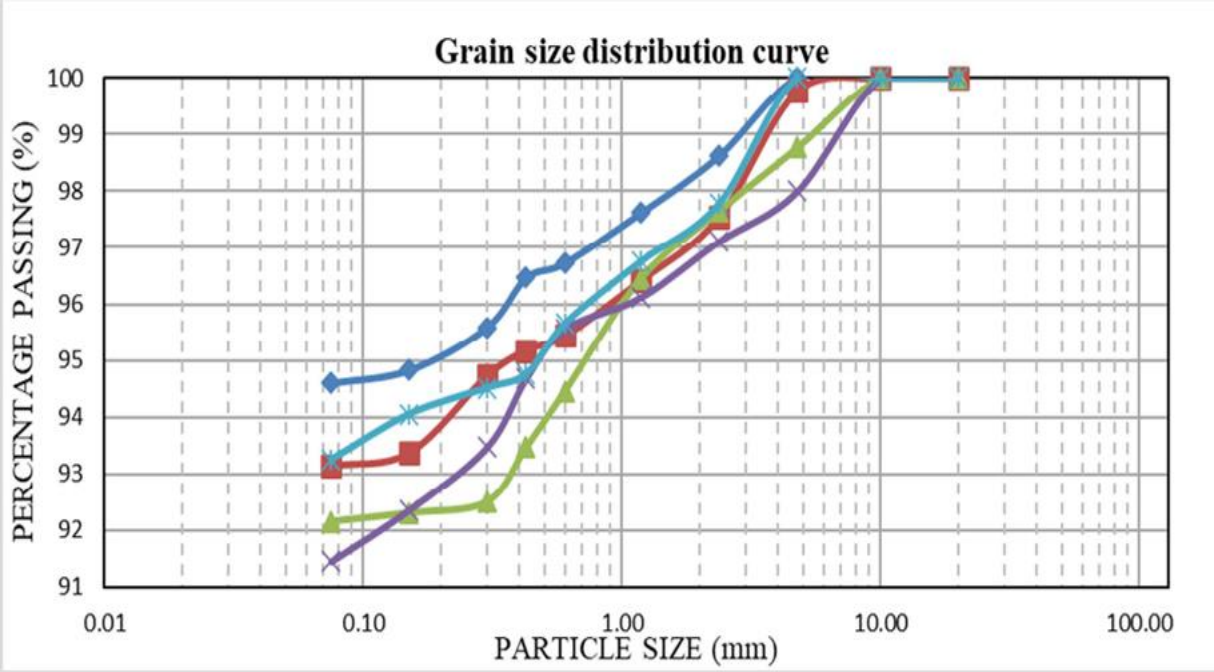
IV. RESULT AND DISCUSSION

A. Engineering Properties of Black Cotton Soil

Table No-03 Black Cotton Soil Properties

Properties	Black Cotton Soil
Colour	Greyish Black
Specific Gravity	2.548
Free Swell Index (%)	95
GRAIN SIZE DISTRIBUTION	
Gravel (%)	0.69
Sand (%)	6.39
Silt / Clay (%)	92.92
IS Classification	CH
ATTERBERG'S LIMIT	
Liquid Limit (%)	27.28
Plastic Limit (%)	36.11
Plasticity Index (%)	38.54
Shrinkage Limit (%)	13.2
COMPACTION CHARACTRISTIC	
Maximum Density (g/cc)	1.45
Optimum Moisture Content (%)	15
CALIFORNIA BEARING RATIO (UNSOAKED)	
2.5mm penetration (%)	4.45
5mm penetration (%)	3.30

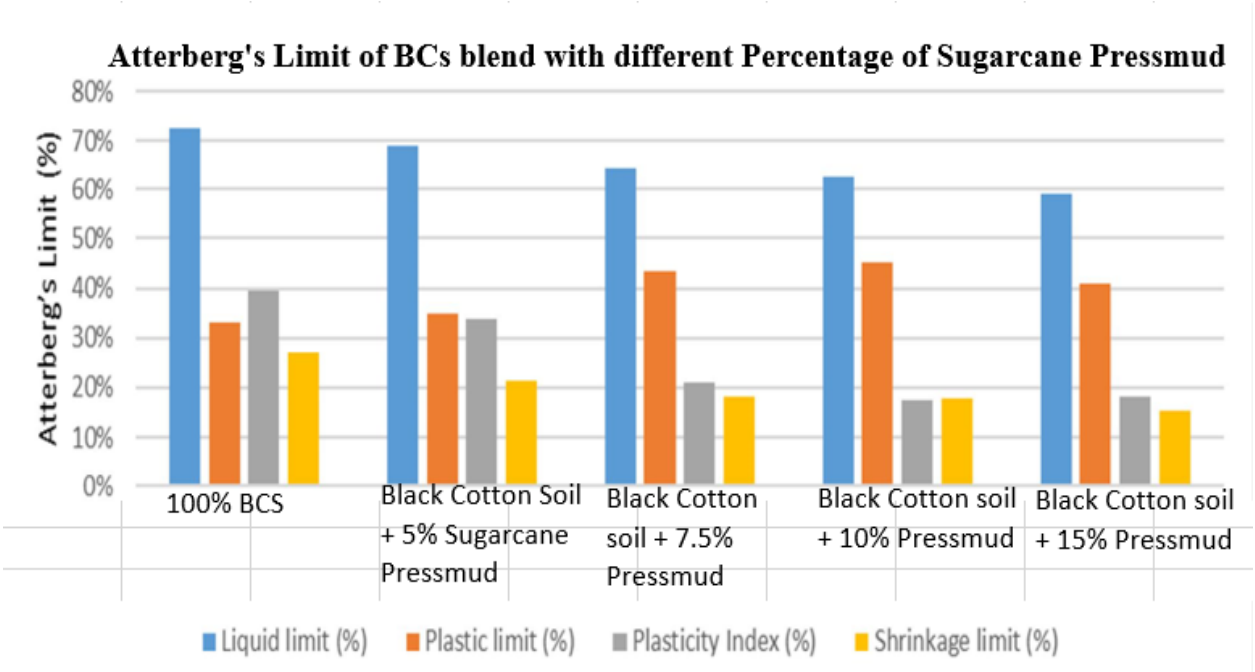
B.Sieve Analysis of Raw Black cotton Soil



Graph.1 Grain size distribution curve for black cotton soil

C. Tests on Lime Added Black Cotton Soil

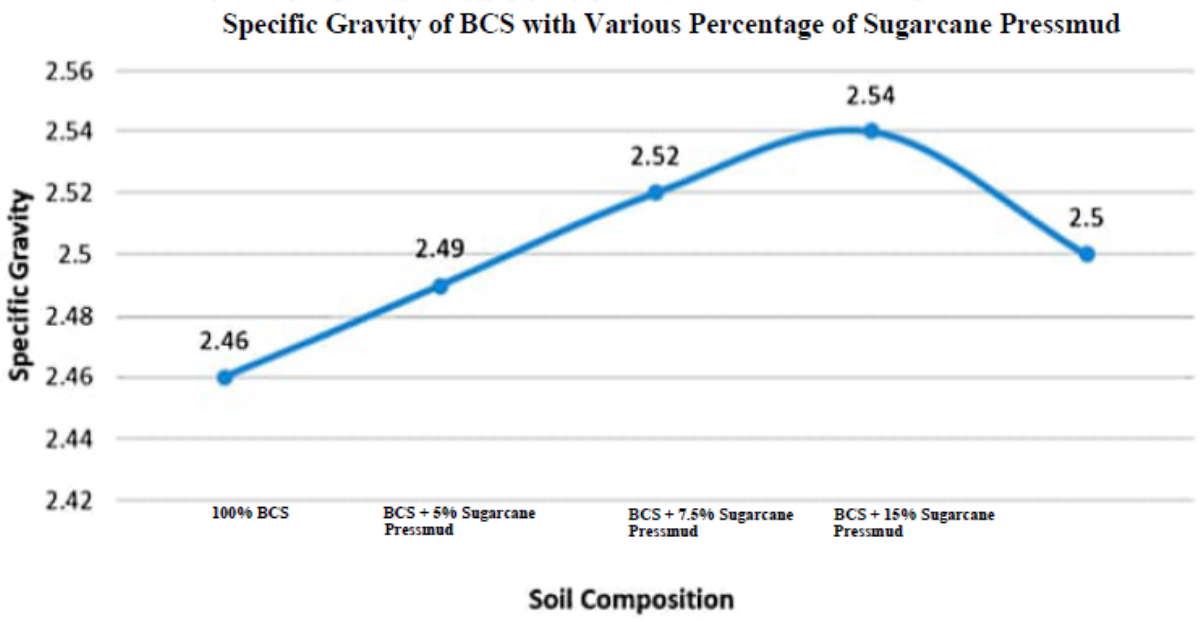
1) Atterberg's Limit test result for different percentage of Sugarcane Pressmud.



Graph No.-02 Graphical comparison of Atterberg's Limits of BCS blend with different percentage of Sugarcane Pressmud

As shown in graph, the liquid limit of the soil alone was found to be 27.57%, Plastic limit is 36.11%, Plasticity Index is 21.43% and Shrinkage limit is 13.2%. It can clearly see that that the Liquid Limit, Plastic limit, Plasticity Index and Shrinkage limit of black cotton soil goes on decreasing with increasing the percentage of Sugarcane Pressmud.

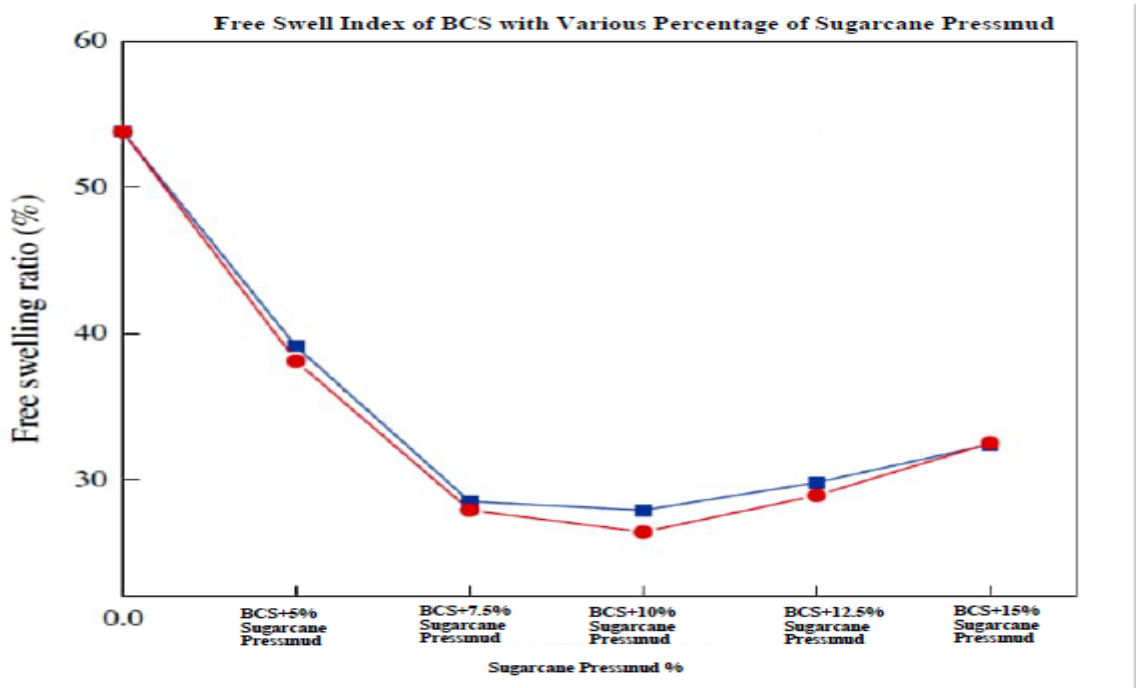
2) Specific Gravity



Graph No-03 Graphical Representation of BCS with various percentage of Sugarcane Pressmud

Graph no.-03 shows the comparison of specific gravity of virgin BC soil with BC soil mixed with 5%,7.5%,10%,12.5% and 15% of Sugarcane Pressmud. It can be seen that specific gravity of BC soil sample raised marginally when 15% Sugarcane Pressmud was added in it. The bars of the virgin BC soil, 5%,7.5%,10% & 12.5% Sugarcane Pressmud mixed BC soil are small as compared to the result bar of 15% sugarcane Pressmud mixed BC soil.

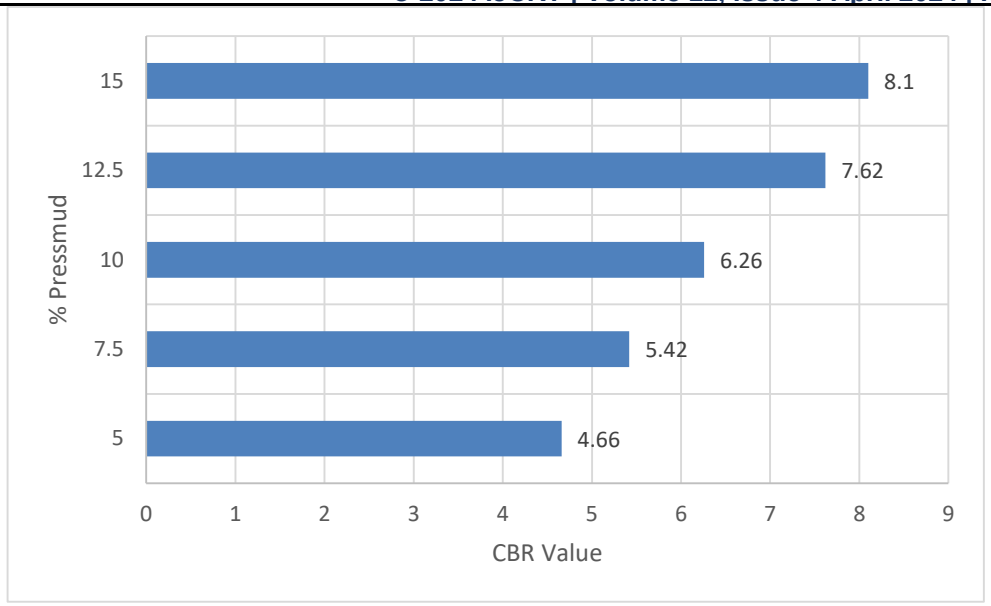
3) Free swell Index Test



Graph No.-04 Graphical Representation of Free Swell Index of BCS with various percentage of lime

It has been observed that the free swell index value continuously decreases with increase of Sugarcane Pressmud content from 5% to 15%. The FSI value decreases from 55% to 35% at 5 to 15% of lime. Hence lime blended soils will be more volumetrically stable than soil alone.

4) California Bearing Ratio Test (CBR)

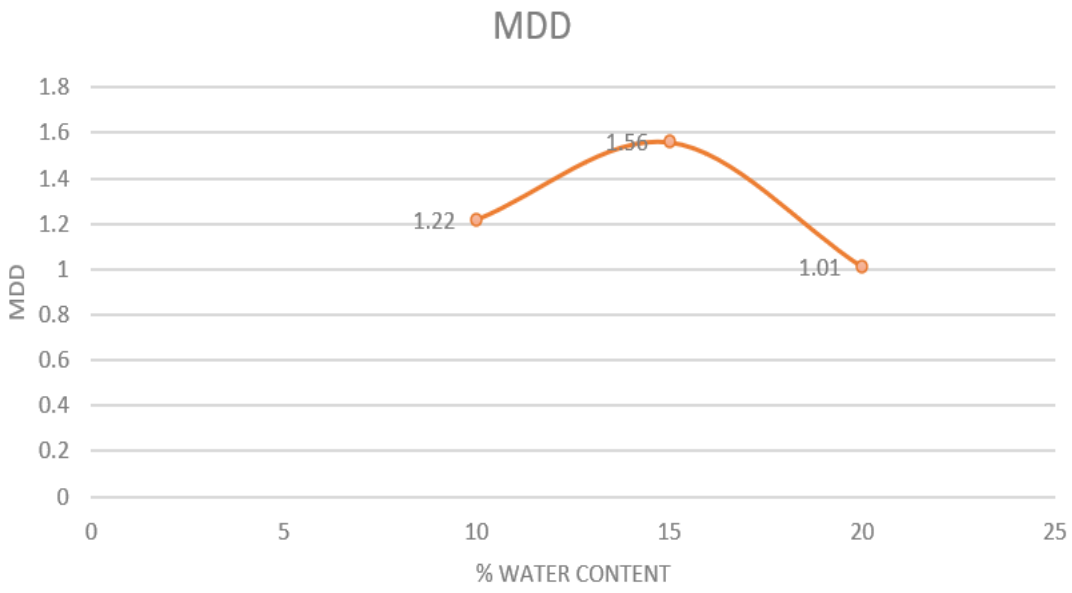


Graph No-07. Graphical representation of CBR Values of BCS Blend by Various percentage of Sugarcane Pressmud

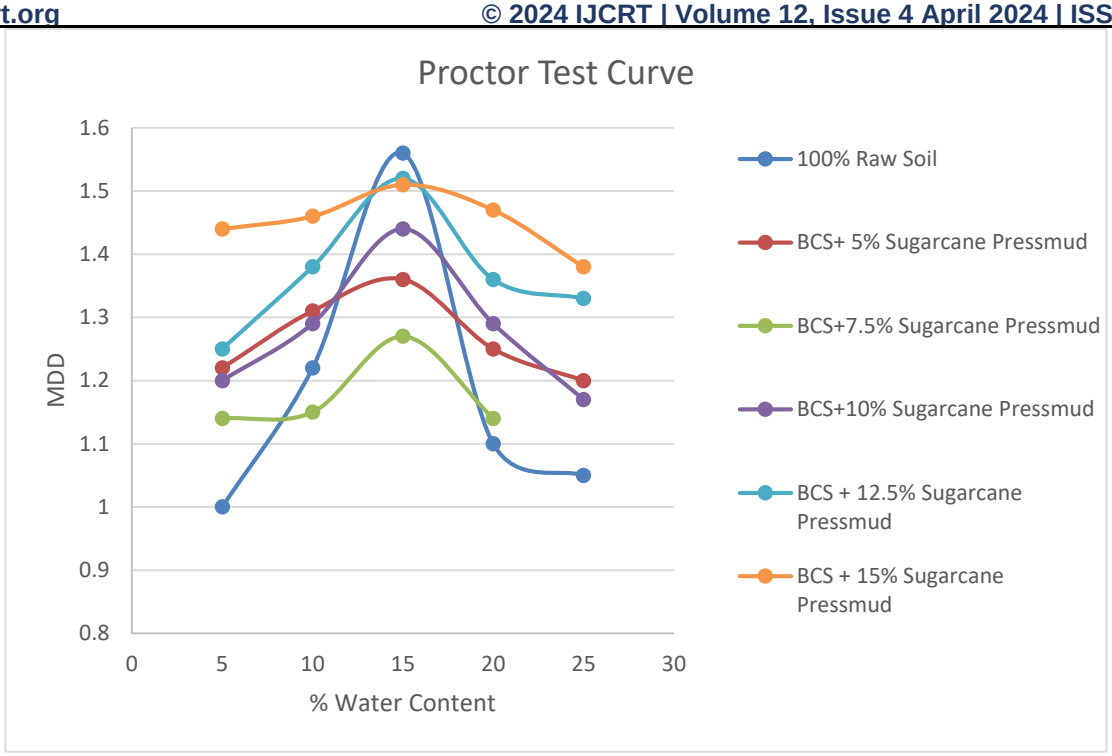
The test has been conducted on the BC soil with different percentages of lime by weight of raw BC soil. In this graph the load penetration bar (2.5mm and 5mm) of the BC soils with the addition of lime (5%,7.5%,10%,12.5% & 15%) is formed which clearly depicts that as the Sugarcane Pressmud content increases the load penetration value increases. The black cotton soil with 15% Sugarcane Pressmud shows the highest limit of load bearing value of 8.10% and 6.60% at the penetration of 2.5mm and 5mm.

5) Soil + Sugarcane Pressmud Result

1. Modified Proctor Test



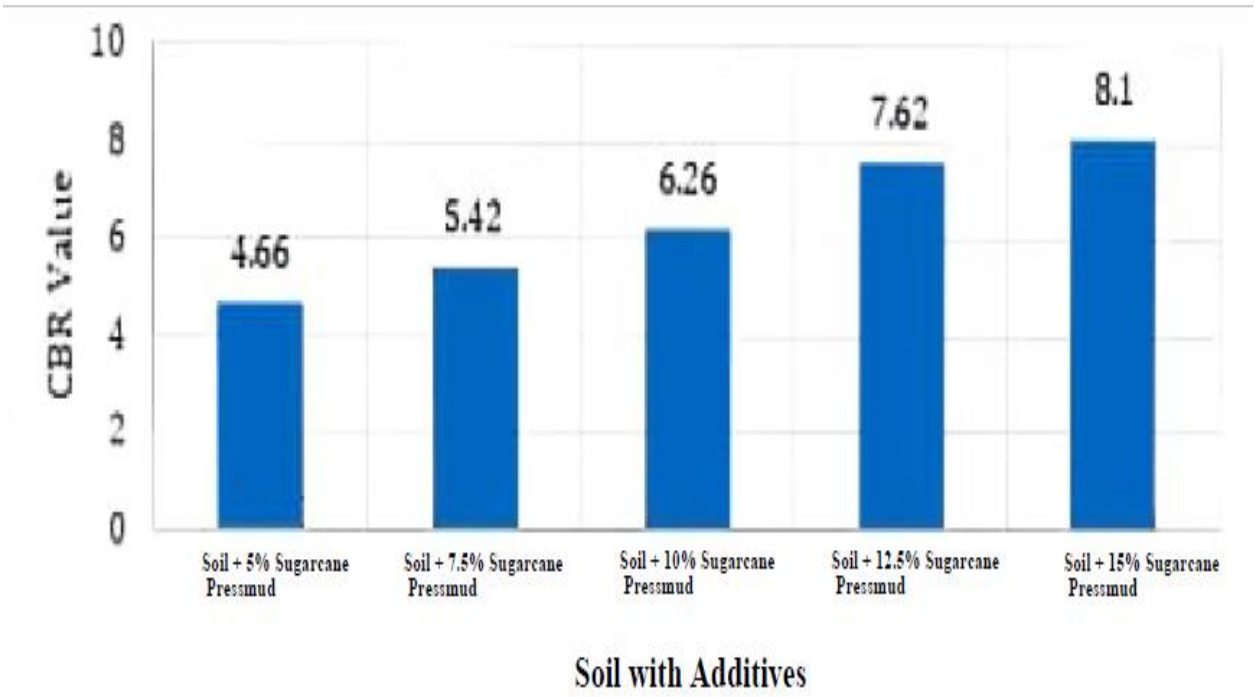
Graph 5.4 Compaction on black cotton soil without stabilizer



Graph 5.9 Compaction test on 15% water

It has been observed that the black cotton soil is having 1.52 gm/cc maximum dry density and optimum moisture content of 15%. With increasing the percentage of Sugarcane Pressmud in black cotton soil, the maximum dry density and optimum moisture content is increased with increasing the optimum percentage of Sugarcane Pressmud.

2. California Bearing Ratio Test



Graph No.-10 Graphical representation of CBR Values of BC Soil Blend with Various percentage of Sugarcane Pressmud.

V. CONCLUSION & FUTURE SCOPE

5.1 Conclusion:

The basis on present experimental study, conclusions are drawn:

1. There is substantial increase in MDD with increase in addition of Additives up to 15% by the weight of soil.
2. There is substantial decrease in OMC with increase in addition of additives.
3. Shrinkage limit values decrease with increases percentage additives.
4. CBR of the soil obtained as 4.45 % and it increased to 8.10% after stabilizing it with optimum percentage of Alum sludge.
5. The percentage increase in CBR value after stabilizing it with optimum percentage of Sugarcane Pressmud 15%.
6. The California bearing ratio of the soil alone obtained and their substantial increase CBR value by adding of Sugarcane Pressmud till optimum Content (15%) and beyond which not that much increasing in CBR value.
7. From above the investigation, can be concluded that the addition of Sugarcane Pressmud + Black cotton soil decreases the swelling behavior, shrinkage limits, increases the MDD of soil, decreases plasticity index, increases the Plastic-limit, and improves soil CBR value.

5.2 Future Scope

In future we can use Pressmud so that we will built any structure and objective at any region and any type of topographical area. If we will add some other component in pressmud it increases the index properties and engineering properties which help to exchange any other construction material to decrease the construction cost. The development of strategies for its various reuse applications is an urgent priority for the future. The rapid progress of research inPressmud sciences has shown its growing potential for implementation in various pavement design. The mechanism behind these studies are the properties of pressmud, large specific surface area, certain pore volumes and porosity of pressmud, as well as its wide availability across the world.

In this investigation total work is based on the strength characteristics of the soil. It can also bedone based on the Atterberg limits by the addition of strength improvement materials like lime,cement, rise husk ash and etc. strength improvement can be conducted different types of tests like modified proctor test to find maximum dry density, optimum moisture content and plate load test to find strength of the soil sub grade. Plate load test is generally used in sites (In situ condition). Thickness of the pavement can be reduced by the improvement in strength of the sub grade soil through the traffic calculation at the selected area. Thickness can find from the recommendations given by Indian road congress.

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