A MAJOR PROJECT REPORT

ON

"EFFECT OF AGRICULTURAL WASTE ON BENTONITE SOIL"

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CERTIFICATE

This is the certification that the project entitled **"Effect of agricultural waste on bentonite soil"** which is being submitted by **Yatin Singh Yadav** in partial fulfillment for the award of the Degree of Bachelor of Engineering in Civil Engineering is a record of their own work carried under my guidance and supervision.

All the information in this document has been obtained and presented in accordance with academic rules and ethical conduct. To the best of your knowledge, the matter presented in this project has not been submitted for the award of any other diploma or degree certificate.

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Yatin Singh Yadav

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ABSTRACT

This project is an analysis of changes in the physical properties of soil after mixing agricultural waste with it. In addition to that, a positive impact has been observed on sodium bentonite soil and calcium bentonite soil after adding agricultural waste. This research is also helpful in providing the solution to the problem of agricultural waste sustainably, promoting zero waste in agricultural production. Where sugarcane bagasse and rice husk ash are incorporated along with sodium bentonite clay and calcium bentonite clay to provide stability and cut down the swelling of bentonite soil.

ABSTRACT IN HINDI

यह परियोजना कृषि अपशिष्ट को इसमें मिलाने के बाद मिट्टी के भौतिक गुणों में परिवर्तन का विश्लेषण है। इसके अलावा, कृषि अपशिष्ट डालने के बाद सोडियम बेंटोनाइट मिट्टी और कैल्शियम बेंटोनाइट मिट्टी पर सकारात्मक प्रभाव देखा गया है। यह शोध कृषि उत्पादन में शून्य अपशिष्ट को बढ़ावा देने, कृषि अपशिष्ट की समस्या को स्थायी रूप से हल करने में भी सहायक है। जहां गन्ने की खोई और चावल की भूसी की राख को स्थिरता प्रदान करने और बेंटोनाइट मिट्टी की सूजन को कम करने के लिए सोडियम बेंटोनाइट क्ले और कैल्शियम बेंटोनाइट क्ले के साथ मिलाया जाता है।

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RHA	Rice husk ash
SCBA	Sugarcane baggase ash
IS	Indian Standard
PL	Plastic Limit
LL	Liquid limit
CBR	California Bearing Ratio
UCS	Unconfined Compression Strength

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CHAPTER I

INTRODUCTION

1.1 General

The primary environmental issues all around the globe are the manufacturing and accumulation of waste. Many issues have to be taken into account, especially, the ones from the objectives given by the European Union. These troubles associated with waste, collectively with the exhaustion of many assets, direct the European Union towards an approach of zero waste via the circular economy. The transition to a greater circular economy, in which the cost of products, materials, and resources is maintained in the economic system for as long as possible, and the era of waste is minimized is a vital contribution to the EU's efforts to expand a sustainable, low-carbon, resource-efficient, and competitive economic system. Bentonite is a rock term. Bentonites are comprised predominantly of the smectite group of minerals. Table 20 suggests the clay minerals that make up the smectite group. The most generals are sodium and calcium montmorillonites. Calcium montmorillonite is the maximum major of the smectite minerals and is located in lots of regions of the world. Sodium montmorillonite is quite uncommon in occurrence in contrast with calcium montmorillonite. The biggest and best-known occurrence is in the states of Wyoming and Montana in the United States. Saponite occurs in some regions of the world and hectorite. beidellite, and nontronite are uncommon. Nontronite occurs especially in iron-rich soils. Volkonskoite and sauconite are extremely uncommon and can occur in only one location. Beidellite is aluminum montmorillonite and is also quite uncommon in occurrence There is a developing body of literature that acknowledges the significance of soil stabilization with the help of agricultural waste. Much agricultural waste sugarcane baggage, rice husk ash, and so on in this project we use sugarcane bagasse, and rice husk ash was used to enhance the stabilization of difficult soil. The agriculture additive commonly acts as an agent that has various and modifies the performance of soil. Bentonite is a clay mineral particle with silica tetrahedral sheets and one octahedral sheet. the primary mineral group in bentonite clay is the smectite group and the mineral is montmorillonite which has a double diffusion layer. Two varieties of major ion exchanger that usually differentiates between sodium bentonite clay and calcium bentonite clay are Na^+ and Ca^+ion respectively. The excessive tendency of water absorption from Na^+ ion in sodium makes it susceptible to soak up a lot of water because it can, this could be known as the excessive swelling bentonite. on the opposite hand, the Ca^+ ion that still has excessive Mg^+ in the calcium montmorillonite is much less vulnerable to water absorption and has been referred to as less bentonite.

1.2 Sugarcane bagasse

Bagasse, also referred to as megass, is fiber remaining after the extraction of the sugar-bearing juice from Sugarcane. The word bagasse, from the French baggage through the Spanish bagazo, originally meant "rubbish," "refuse," or "trash. Initially applied to the debris from the pressing of olives, palm nuts, and grapes, the word was eventually used to intend residues from different processed plant substances which include sisal, sugarcane, and sugar beets. In present-day use, the word is restrained to the by-product of the sugarcane mill. Bagasse is burned as fuel in the sugarcane mill or used as a source of cellulose for producing animal feeds. paper is made from bagasse in numerous Latin American nations, in the middle east, and in sugar-manufacturing nations which are poor in forest resources. Bagasse is the crucial factor for the manufacturing of pressed building boards, acoustical tile, and different construction materials and can be made into numerous biodegradable plastics. Bagasse is also used in the manufacturing of furfurals, a clear colorless liquid used in the synthesis of chemical products which include nylons, solvents, and even medicines. Bagasse is biodegradable and has ample benefits, ranging from higher-temperature tolerance, and great durability, and it is compostable too. This is the purpose why now no longer only it is used as a key element for eco-friendly packaging but is also used to manufacture biodegradable disposable tableware. Ecoware is an environment-friendly tableware manufacturer.

Fig. 1 Sugarcane bagasse ash

1.3 Rice husk ash

Rice husks are the hard protective coverings of rice grains that are separated from the grains while the milling process. Rice husk is an easily accessible waste material in all rice-producing nations, and i consists of approximately 30%–50% of organic carbon. In the course of a standard milling process the husks are eliminated from the raw grain to expose whole brown rice which upon further milling t remove the bran layer will yield white rice. Current rice manufacturing around the globe is expecte to be seven hundred million tons. Rice husk constitutes approximately 20% of the mass of rice and its composition is as follows: cellulose (50%), lignin (25–30)%, silica (15–20)%, and moisture (10–15)%. The bulk density of rice husk is low and lies in the range of 90to150 kg/m3. Sources of rice husk ash (RHA) can be in the rice-producing areas of the world, for example, China, India, and the far-East nations. RHA is made from the incineration of rice husk. Most of the evaporable components of rice husk are slowly lost while burning and the major residues are the silicates. The characteristics of the ash are based on (1) the composition of the rice husks, (2) the burning temperature, and (3) the burning time. Every 100 kg of husks burnt in a boiler for instance will yield approximately 25 kg of RHA. In some areas, rice husk is used as a fuel for parboiling paddy in rice mills, while in a few regions it is field-burnt as a local fuel. However, the combustion of rice husks in such cases is far from complete and the partial burning additionally contributes to air pollution. The calorific value of rice husks is nearly 50% of that of coal, and assuming that husks have approximately 8%–10% of moisture content and absent bran, the calorific value is expected to be 15 MJ/kg. Under controlled burning conditions, the inflammable organic matter of rice husks such as cellulose and lignin are eliminated and the residual ash is predominantly amorphous silica with a (microporous) cellular structure Due to its fairly microporous shape, the specific surface area of RHA as analyzed through the Brunauer–Emmett–Teller (BET) nitrogen adsorption technique can vary from 20 to as high as 270 m2/g, and that of silica fume, as an example is in the range of 18–23 m2/g.

Physical Properties

RHA is gray-black in color due to unburned carbon. At burning temperatures of 550 – 800 °C, unformed silica is formed, while crystalline silica is produced at advanced temperatures. The specific graveness of RHA varies from2.11 to2.27; it's largely pervious and featherlight, with a veritably high specific face area. Table11.13 shows the physical parcels of RHA reported by several experimenters.Fig.11.2 shows images of RHA as entered and after burning at 700 °C for 6 h (Della etal., 2002). Generally, RHA is used in the form of ground RHA, having typical flyspeck sizes generally less than 10 ìm; natural RHA(NRHA) has larger sizes of roughly 100 ìm.

FIG 2. Rice ash husk

CHAPTER 2

OBJECTIVE

2.1 Problem Statement

The current study's challenge is labeled " Effect of agricultural waste on bentonite soil"
Extended soil is one of the most troublesome soils, as it has the most potential for shrinking or swelling owing to humidity fluctuations. Large swaths of land can be found on practically every continent.Bentonite is a type of expanding soil that has a lot of volume fluctuations. Many countries have experienced negative consequences from this sort of soil.
This stage of volume change is determined by the constituents' mineralogical composition and value. It has an impact on all forms of structures.A fundamental issue with expanded soils is that the alteration is much larger than the elastic structure, making it impossible to forecast using traditional elastic or plastic theories.

2.2 Objective

The objective of the present study are

- To investigate the physical properties of calcium and sodium bentonite;
- To investigate the fluctuation in index properties of soil when sugarcane bagasse and rice husk ash are added; and
- To assess the stability of sugarcane bagasse and rice husk ash in bentonite soil.

CHAPTER 3

3.1 LITERATURE REVIEW

In order to check the closely and sparsely related studies within the field of stabilization techniques, a literature survey was dispensed. the assorted journals and books like ASCE, CRRI, Science Direct ,and Advanced Handbooks Etc .were referred for the analysis of the current problem. Research papers associated with waste stabilization were studied and a few of the websites on the net were scanned and relevant studies were downloaded for review and finalization of this topic.

- Practicing geotechnical engineers generally advocate the direct shear test with a shear box for granular soils to determine cohesion and angle of internal friction, according to Muawia A. Dafalla. The major element in the clay liners is sand, with clay added in varied amounts.
- According to EC Brevik, a scientist, a holistic study of soils necessitates an interdisciplinary approach encompassing biologists, chemists, geologists, and others, which has been true since the field's inception.
- Accoding to major project report experimental study of fly ash and kota stone slurry as stabilising materials under Dr. Chayan Gupta the challenge of industrial waste disposal prompted research into the possibility of industrial waste (fly ash, silica fumes) in stabilising Kota stone slurry used as soil material.Soil stabilisation is a chemical or mechanical treatment that aims to improve or preserve a mass of soil's stability or other engineering features. The process of stabilising Kota stone with fly ash is both straightforward and pollution-free.
- Accoding to research paper of Nurmunira Muhammad , Sumi Siddiqua with this data understand the difference in the properties of different type of bentonite soil and also how replace the problematic bentonite soil with high bulk density soil .
- Accoding to research paper of ARTHUR G. Clelyi and ROBERT W. DOEHLER American Colloid Company, Skokie, Illinois understand uses of bentonite soil in industries Plasticity develops in the combination as the water adsorption capacity of the bentonite is barely exceeded as the water-to-clay ratio is increased. In some ceramics, this clay-water mixture is employed as a plasticizing agent. concrete and wares

CHAPTER 4

METHODOLOGY

The physical features of bentonite soil and different mix proportions of sugarcane bagasse and rice husk ash were determined through a series of studies. The inquiry was carried out to see if sugarcane bagasse and rice husk ash might be used as stabilization materials. In reality, finding an efficient and cost-effective application of sugarcane bagasse and rice husk ash in stabilizing will necessitate much testing and inquiry. Experiments were carried out in this study to see if sugarcane bagasse and rice husk ash might be used in a practical way. First, specific qualities of bentonite soil were investigated, as well as changes in the behavior of physical properties. All of the experiments were first carried out on plain bentonite soil, and then we mixed farm waste sugarcane bagasse and rice husk ash into it.Consistency of Soil(as perIS2720:Pt.5-1995). First, we conducted all of our tests on plain bentonite soil, and then we mixed agriculture waste sugarcane bagasse and rice husk ash in various proportions in bentonite soil, such as 5%, 10%, 15%, and 20%.

Consistency is a term used to indicate the degree of firmness of cohesive soils. The consistency of natural cohesive soiled positsisex pressed qualitatively by such term verysoft, soft, stiff, very stiff, and hard. The physical properties of clays greatly differ in different water contents. A soil that is very soft at a higher percentage of water content becomes very hard with a decrease in water content.

However, it has been found that at the same water content, two samples of clay of different origins may possess different consistency. One clay may be relatively soft while the other may be hard. Further, a decrease in water content may have little effect on one sample of clay but may transform the other sample from almost a liquid to a very firm condition.

4.1 Atterberg limits (IS 2720 -5(1985))

In 1911, a Swedish scientist named Atterberg studied soil consistency and established a set of tests to define the qualities of cohesive soils. As the amount of water in the mixture grows, the strength falls. Soil behaves more like a solid with very low moisture content. When the moisture level of the soil and water is extremely high, the soil and water may flow like a liquid. As a result, the behaviour of soil is sometimes categorised into four fundamental stages based on moisture content: solid, semisolid, plastic, and liquid. The Atterberg limits are the water content limitations that are used to determine soil behaviour.

The liquid limit (LL): is the moisture content at which soil begins to flow and behave like a liquid.

Fig 3.1

Fig 3.2

Liquid limit apparatus

Plastic Limit (PL): The moisture content at which soil begins to behave like a plastic material.

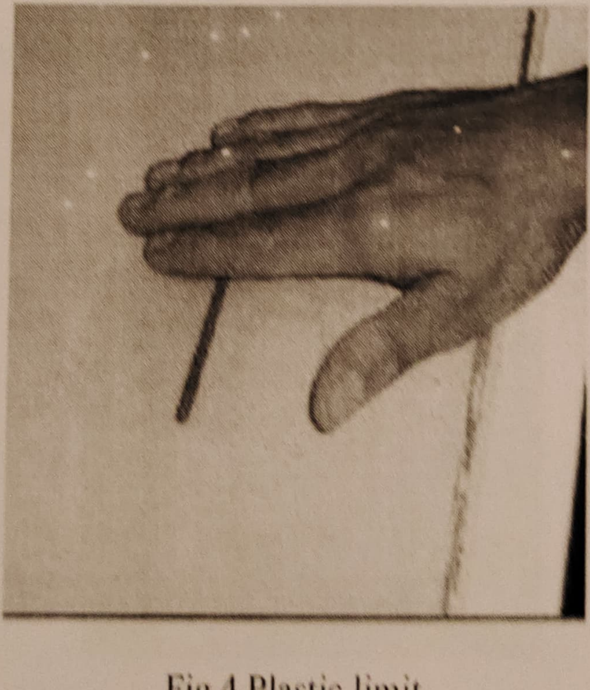


Fig 4 Plastic limit

Shrinkage Limit(SL): is the moisture content below which no additional volume change happens when the moisture content is reduced.

Fig 5.1

Fig 5.2

Shrinkage limit

4.2 Differential Swell Index

To determine the possibility of structural damage due to the swelling of expensive clays, an assessment of those soils likely to have undesirable expansion qualities is necessary. To reflect the system's ability to expand under multiple simulated circumstances, inferential testing is used. The dry density, beginning water content, surcharge loading, and a range of other environmental variables all influence the size of the swelling forces that occur.

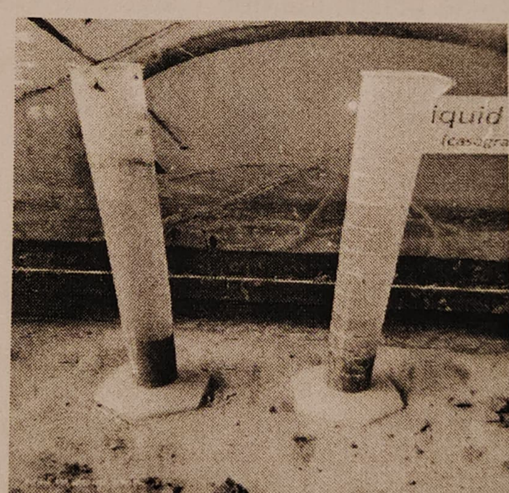


Fig 6 Differential swelling test

4.3 Specific Gravity

The weight of an equivalent volume of distilled waters at that temperature, both weights obtained in air, is defined as the specific gravity 'G'. Specific gravity is utilised in the calculation of soil parameters such as void ratio, degree of saturation, and so on since it is required in the phase relationship of air, water, and solids in a given volume of soil.

Fig 7 Specific density bottle

4.4 Hydrometer

A hydrometer is a device that measures specific gravity. It works on the Archimedes Principle, which states that a solid thing floats in a liquid and displaces its own weight. Liquids heavier than water and liquids lighter than water are the two categories of hydrometers. Distilled water equals 1.000, the starting point of measurement on the standard hydrometer scale, also known as the specific gravity scale. Liquids with a specific gravity less than 1.000 are scaled below 1.000, whereas liquids with a specific gravity more than 1.000 are scaled beyond 1.000.

4.5 Compaction

R. R. Proctor, a field engineer for the Bureau of Waterworks and Supply in Los Angeles, California, devised the Proctor test in the 1930s. The most popular laboratory test used to determine the compressibility of soils is the procedure, which simulates in-situ compaction processes commonly used during the construction of earth dams or embankments.Because the type of compaction and the amount of energy provided for a given soil volume are both standards, the test focuses on the change in moisture content of a sample to determine the optimum water content (wopt).

A 0.95-liter volume cylindrical mould is used in the typical Proctor test, in which the soil mass is put and compacted in three layers. Each layer is compacted by dropping a 2,5 kg weight from a height of 30 centimetres 25 times.

Fig 8.1

Fig 8.2

Compaction Apparatus

4.6 California Bearing RatioTest (asperIS2720: Pt.16-1997)

The CBR test can be done on undisturbed soil specimens obtained by fitting a cutting edge to the mould or on remoulded specimens, according to the BIS. Remolded soil specimens can be compacted using either static or dynamic compaction methods. When static compaction is used, the soil is combined with water to achieve the needed moisture content; the correct weight of moist soil is placed in the mould to achieve the desired density; and compaction is achieved by pressing in the spacer using a compaction machine or jack. It is more customary to use dynamic compaction or ramming to prepare soil specimens. Sugarcane bagasse and rice husk were hand-mixed with sodium bentonite and calcium bentoite (15 percent, 18 percent, 21 percent, 24 percent, and 27 percent, respectively).by weight at their corresponding OMC and MDD.

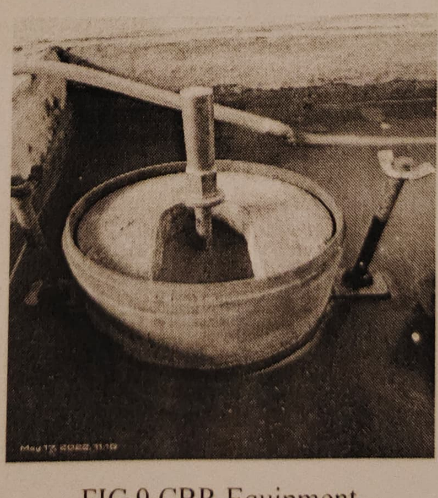


FIG 9 CBR Equipment

4.7 Unconfined Compressive Strength Test (as per IS2720:Pt.10-1995)

The primary goal of this test is to establish the clay's unconfined compressive strength, which is then utilised to compute the clay's unconsolidated undrained shear strength in an unconfined environment. The bearing capacity test is not always practicable to perform in the field. It is sometimes less expensive to take an undisturbed soil sample and assess its strength in a lab. Strength tests on the selected samples are also required in order to determine the appropriate material for the embankment. Under these conditions, performing an unconfined compression test on an undisturbed and remoulded soil sample is simple. On undisturbed or remoulded cohesive soils, unconfined compressive strength (UCS) tests can be performed. It can't be done on coarse-grained soils like sands and gravels since they don't have enough lateral support. A compressive force is applied axially to a conventional cylindrical soil specimen until failure occurs. The test is known as the 'Unconfined Compressive Strength test' since the specimen is not confined laterally. The specimen does not need to be encased in a rubber membrane. The largest principal stress is axial or vertical compression, while the other two principal stresses are nil. Failure occurs along the weakest plane, and the failure plane is not preset.

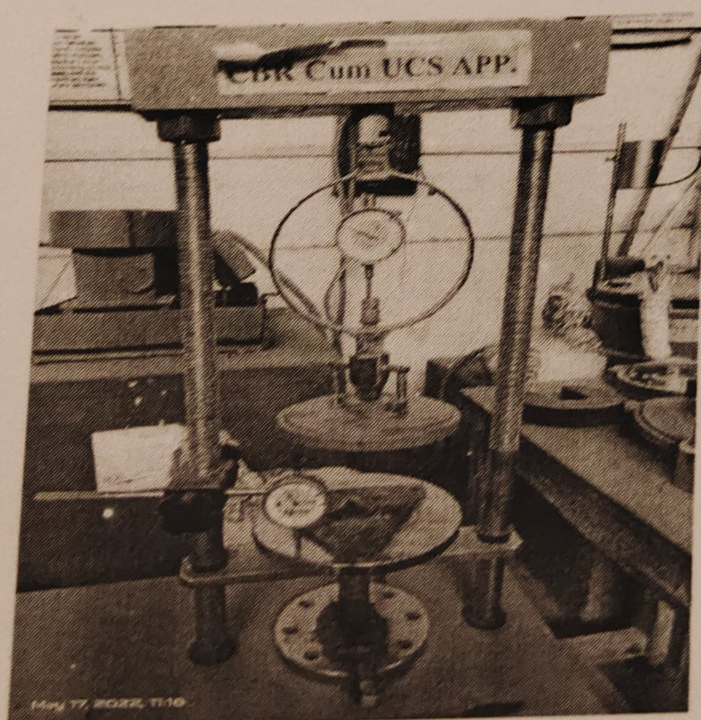


Fig 10 UCS machine

CHAPTER -5

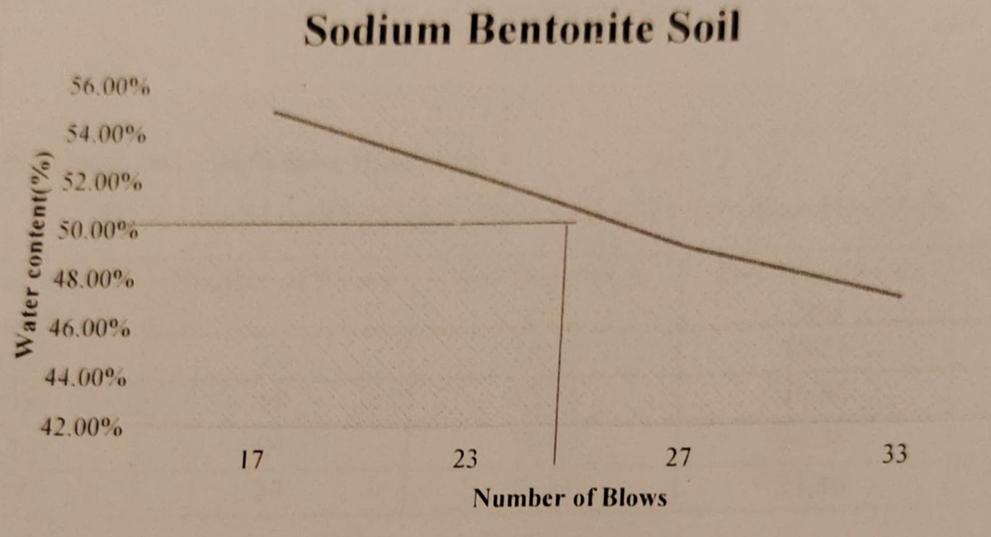
RESULT

LIQUID LIMIT

Sodium Bentonite soil

Table 1. Liquid limit Sodium bentonite soil

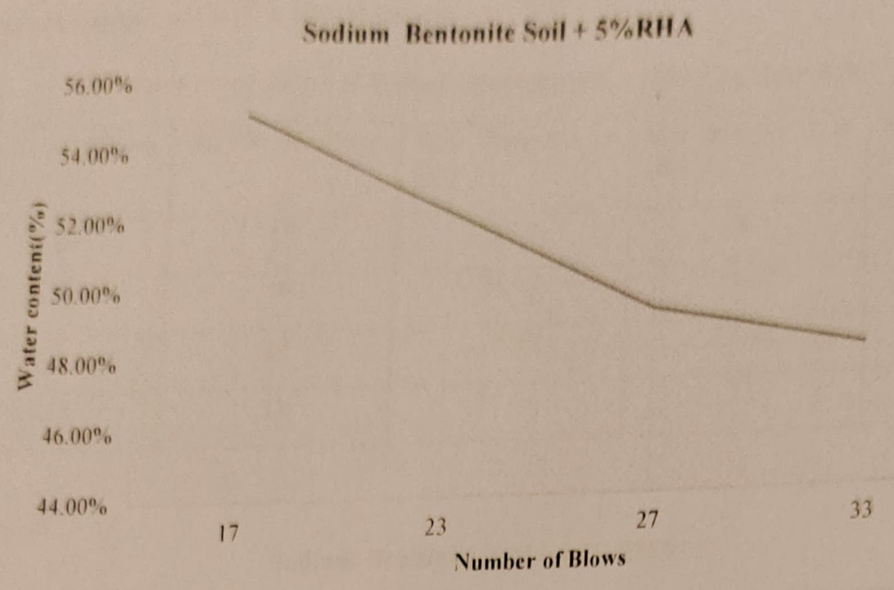
Weight of blows (in gm)	Number of blows	Wet weight (in gm)	Dry weight (in gm)	Water content (%)
14.35	17	47.31	35.63	54.92
14.49	23	43.13	33.84	52.18
14.01	27	46.57	35.84	49.19
13.39	33	49.71	37.43	46.98



Sodium Bentonite soil + 5% Rice Husk Ash

Table 2.liquid limit of Sodium Bentonite soil + 5% Rice Husk Ash

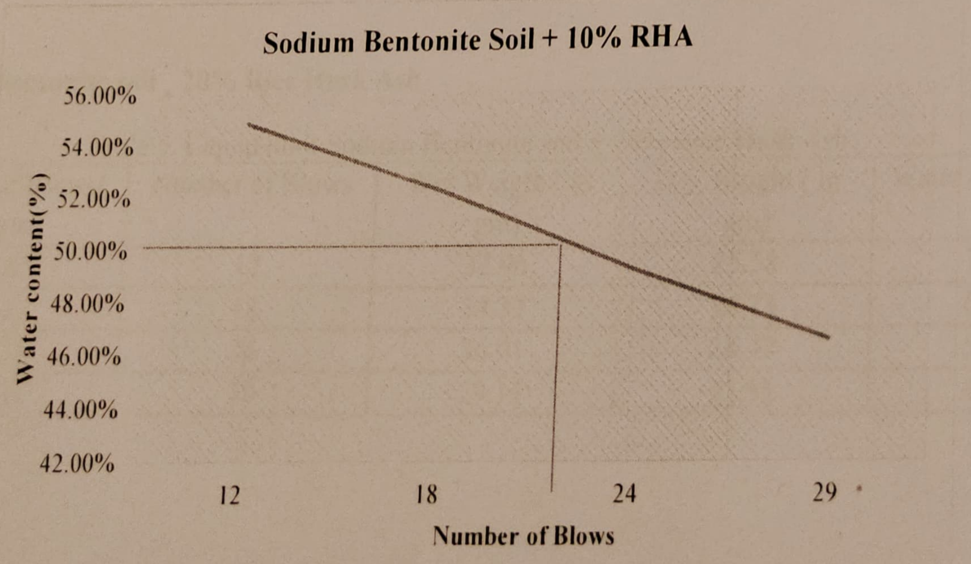
Weight of Blows(in gm)	Number of Blows	Wet Weight (in gm)	Dry Weight (in gm)	Water content (%)
14.35	17	47.31	35.63	54.92
13.89	23	49.71	37.43	52.18
14.01	27	46.57	35.84	49.19
43.13	33	33.84	33.84	47.98



Sodium Bentonite soil + 10% Rice Husk Ash

Table 3.liquid limit of Sodium Bentonite soil + 10% Rice Husk Ash

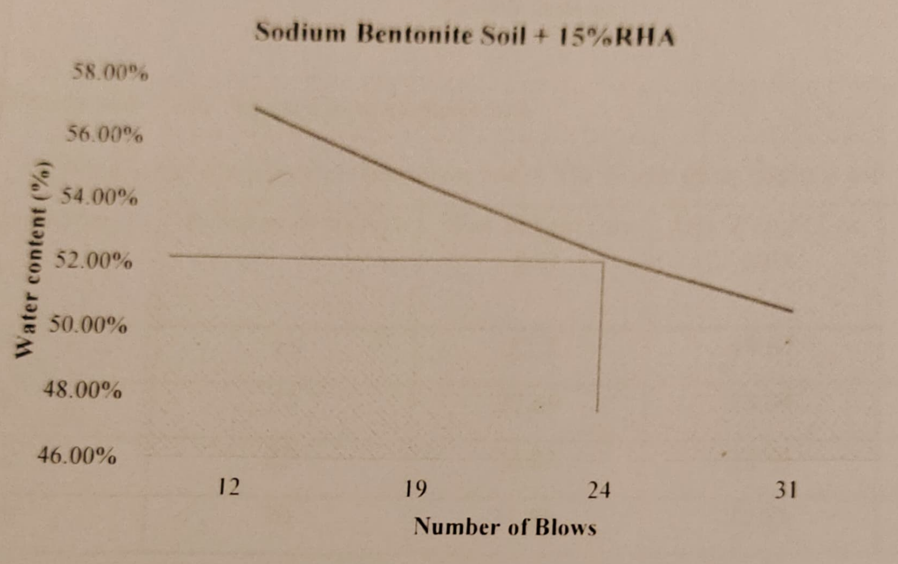
Weight of Blows(in gm)	Number of Blows	Wet Weight (in gm)	Dry Weight (in gm)	Water content (%)
14.47	12	20.72	18.56	54.83
14.36	18	32.31	26.86	52.25
14.13	24	29.97	24.36	48.66
13.96	29	25.11	21.46	46.35



Sodium Bentonite soil + 15% Rice Husk Ash

Table 4.liquid limit of Sodium Bentonite soil + 15% Rice Husk Ash

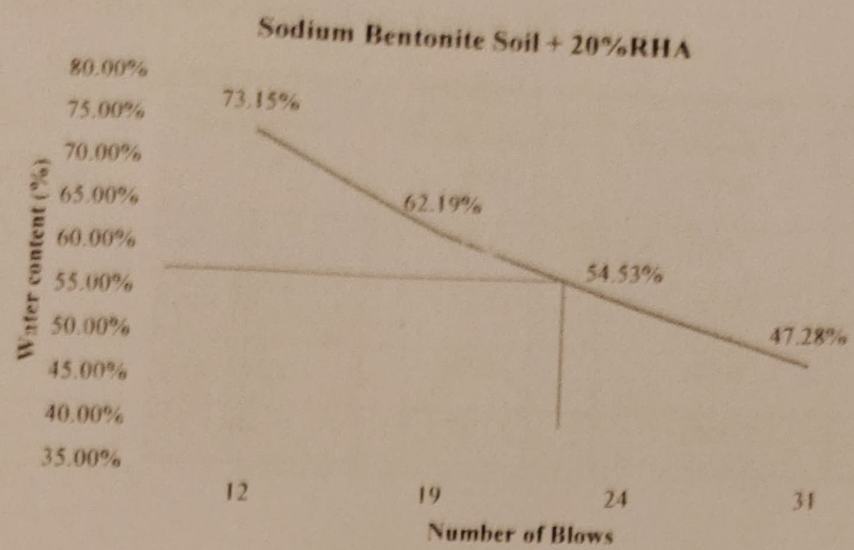
Weight of Blows(in gm)	Number of Blows	Wet Weight (in gm)	Dry Weight (in gm)	Water content (%)
14.79	12	29.4	24.1	56.92
14.11	19	26.73	22.28	54.48
14	24	28.59	23.52	52.33
14.24	31	30.54	25	50.56



Sodium Bentonite soil + 20% Rice Husk Ash

Table 5. Liquid limit Sodium Bentonite soil + 20% Rice Husk Ash

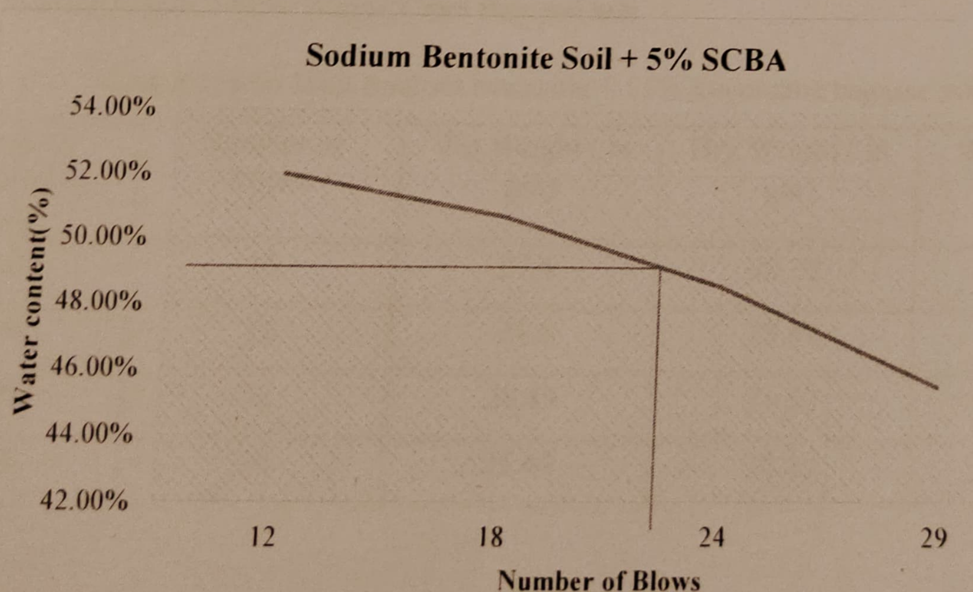
Weight of Blows(in gm)	Number of Blows	Wet Weight (in gm)	Dry Weight (in gm)	Water content (%)
13.85	12	32.96	25.58	73.15
14.25	18	34.32	26.78	62.19
14.36	26	36.01	28.37	54.53
14.21	30	29,14	23.95	47.28



Sodium Bentonite soil + 5% Sugar Cane Bagasse ash

Table 6.Liquid limit Sodium Bentonite soil + 5% Sugar Cane Bagasse ash

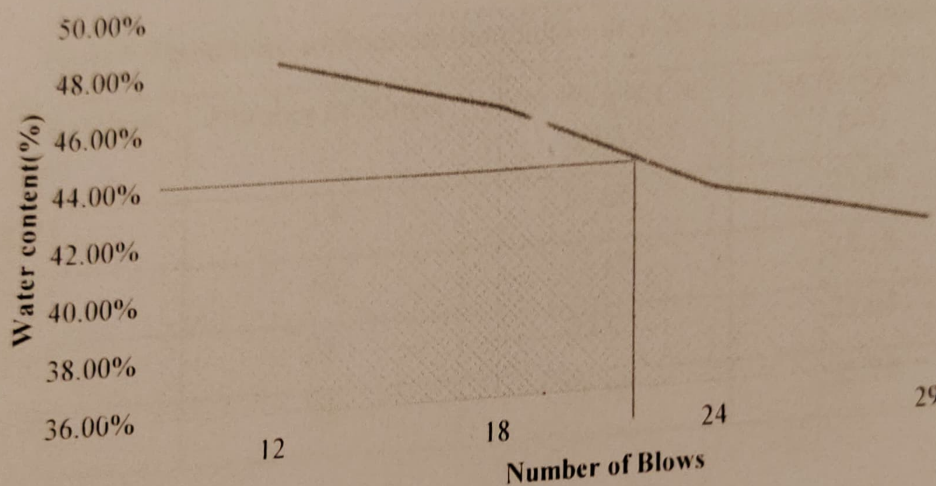
Weight of Container(in gm)	Number of Blows	Wet Weight (in gm)	Dry Weight (in gm)	Water content (%)
14.73	15	22.7	19.62	51.98
14.02	21	27.69	23.04	50.66
14.3	25	26.83	22.54	48.56
14.29	30	31.86	25.85	45.50



Sodium Bentonite soil + 10% Sugar Cane Bagasse ash

Table 70.Liquid limit Sodium Bentonite + 10% Sugarcane Bagasse ash

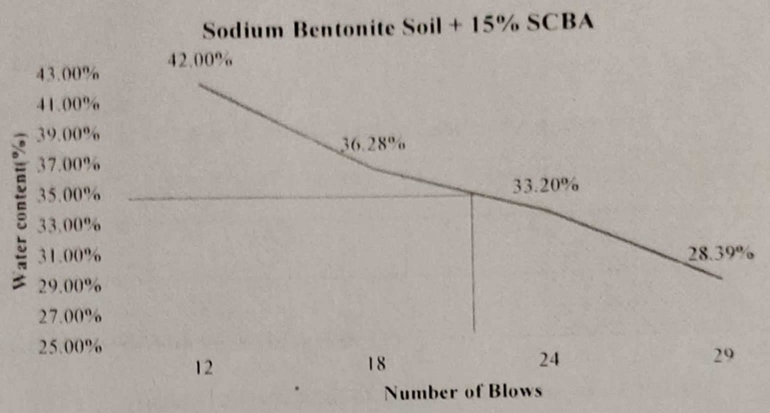
Weight of Container(in gm)	Number of Blows	Wet Weight (in gm)	Dry Weight (in gm)	Water content (%)
14.45	22	23.81	20.84	48.36
14.36	25	21.81	19.61	46.4
14.29	36	25.36	22.03	43.02
14.32	46	21.13	18.91	41.27



Sodium Bentonite soil + 15% Sugar Cane Bagasse ash

Table 8.Liquid limit Sodium bentonite + 15% Sugarcane bagasse ash

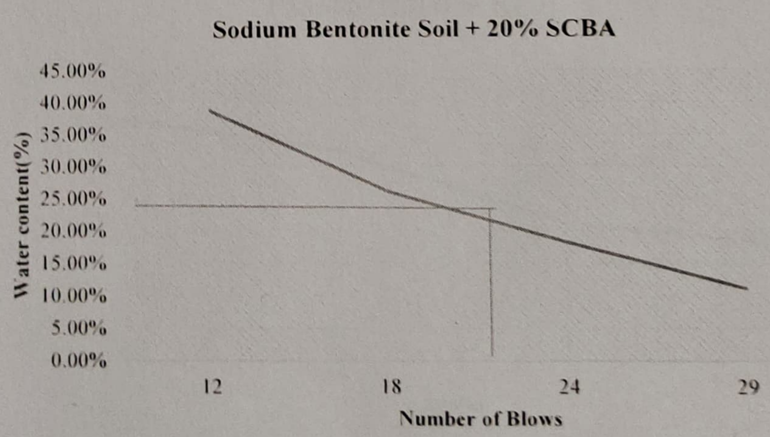
Weight of Container(in gm)	Number of Blows	Wet Weight (in gm)	Dry Weight (in gm)	Water content (%)
14.3	15	27.4	20.22	42.00
14.02	18	23.6	19.42	36.28
14.35	24	28.49	25.32	33.2
14.21	35	25.44	22.45	28.89



Sodium Bentonite soil + 20% Sugar Cane Bagasse ash

Table 9.liquid limit of Sodium Bentonite soil + 20% Sugarcane bagasse ash

Weight of Container(in gm)	Number of Blows	Wet Weight (in gm)	Dry Weight (in gm)	Water content (%)
14.73	13	31.66	25.98	38.55
14.35	16	35.19	28.18	25.98
14.07	25	23.1	23.04	18.26
14.39	35	27.18	,25.74	11.11



PLASTIC LIMIT

Sodium Bentonite soil

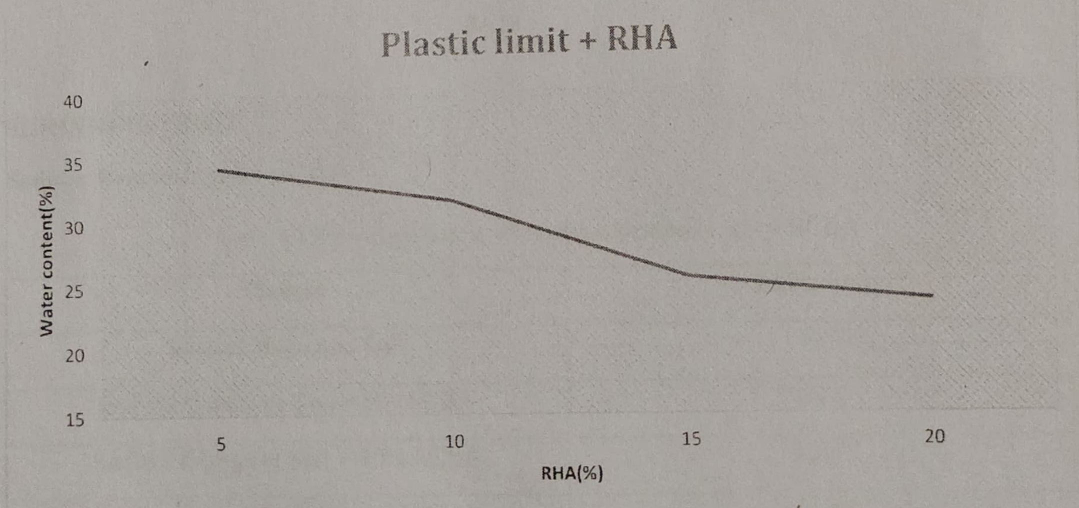
Table 10.Plastic limit of Sodium Bentonite soil

Empty Beaker (gm)	Wet Weight (in gm)	Dry Weight (in gm)	Water content (%)
14.4	16.31	15.8	36.06

Sodium Bentonite Soil With Rice Husk Ash

Table 11.Plastic limit of Sodium Bentonite soil + RHA

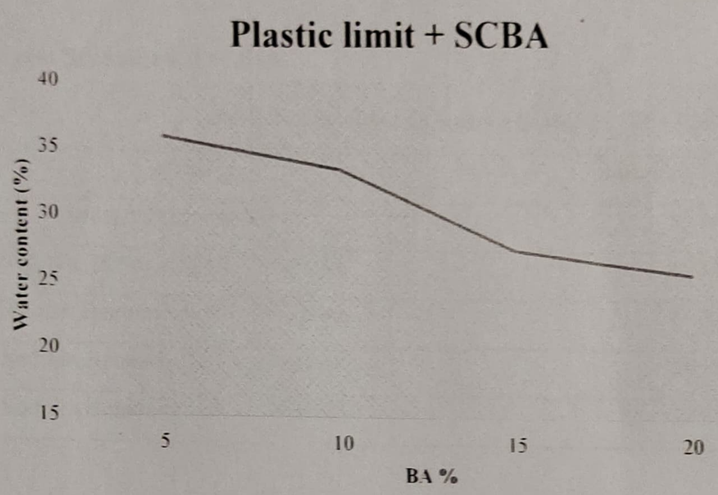
Empty Beaker (gm)	Wet Weight (in gm)	Dry Weight (in gm)	Water content (%)	RHA %
14.03	15.84	15.1	34.28	5
14.33	15.13	14.39	31.53	10
14.37	15.51	14.78	25.43	15
14.9	15.95	15.32	23.58	20



Sodium Bentonite Soil With Sugar Cane Bagasse ash

Table 12.Plastic limit of Sodium Bentonite soil + Sugarcane bagasse ash

Empty Beaker (gm)	Wet Weight (in gm)	Dry Weight (in gm)	Water content (%)	SCBA %
14.2	18.65	17.52	35.85	5
14.31	15.37	17.12	33.47	10
14.2	18.98	17.87	27.49	15
14.23	16.99	16.16	25.62	20

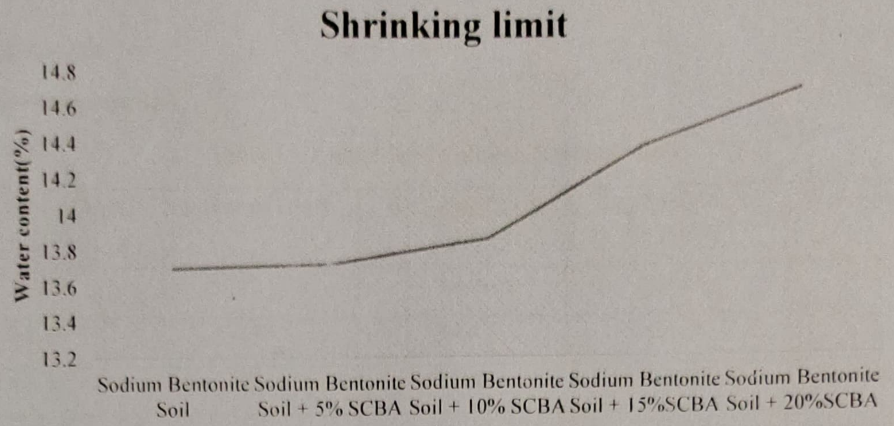


SHRINKING LIMIT

Sodium Bentonite soil + SCBA

Table 13.Shrinkage Limit of Sodium Bentonite soil + SCBA

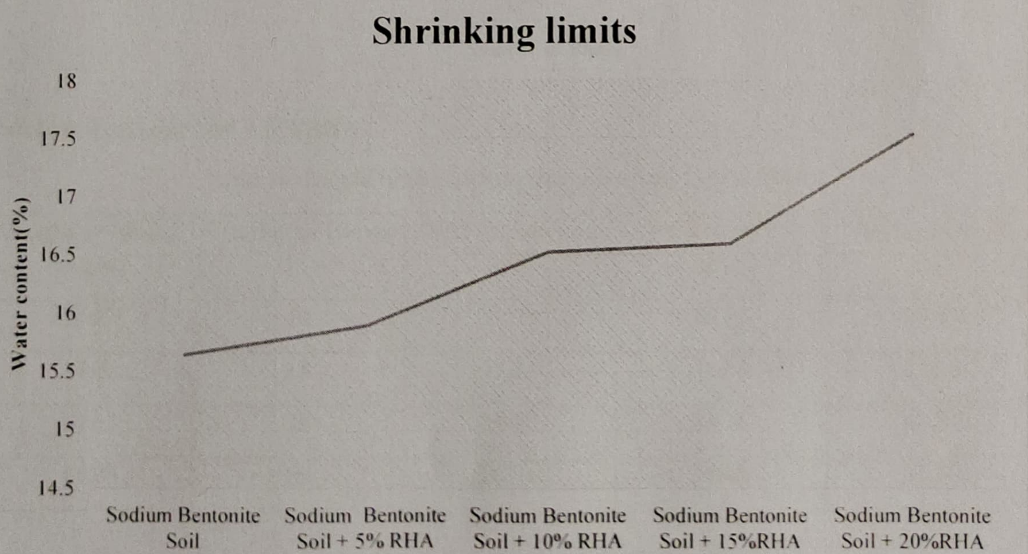
Content	Shrinking limits(%)
Sodium Bentonite Soil	13.7
Sodium Bentonite Soil + 5% SCBA	13.73
Sodium Bentonite Soil + 10% SCBA	13.87
Sodium Bentonite Soil + 15%SCBA	14.39
Sodium Bentonite Soil + 20%SCBA	14.7



Sodium Bentonite soil + RHA

Table 14.Shrinkage of Sodium Bentonite soil + RHA

Content	Shrinking limits(%)
Sodium Bentonite Soil	15.64
Sodium Bentonite Soil + 5% RHA	15.89
Sodium Bentonite Soil + 10% RHA	16.52
Sodium Bentonite Soil + 15%RHA	16.59
Sodium Bentonite Soil + 20%RHA	17.53

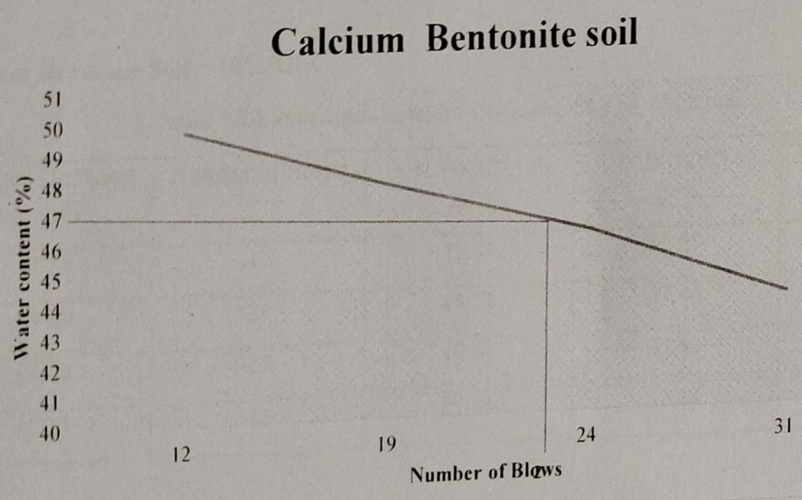


LIQUID LIMIT

Calcium Bentonite Soil

Table 15. Liquid limit Calcium Bentonite Soil

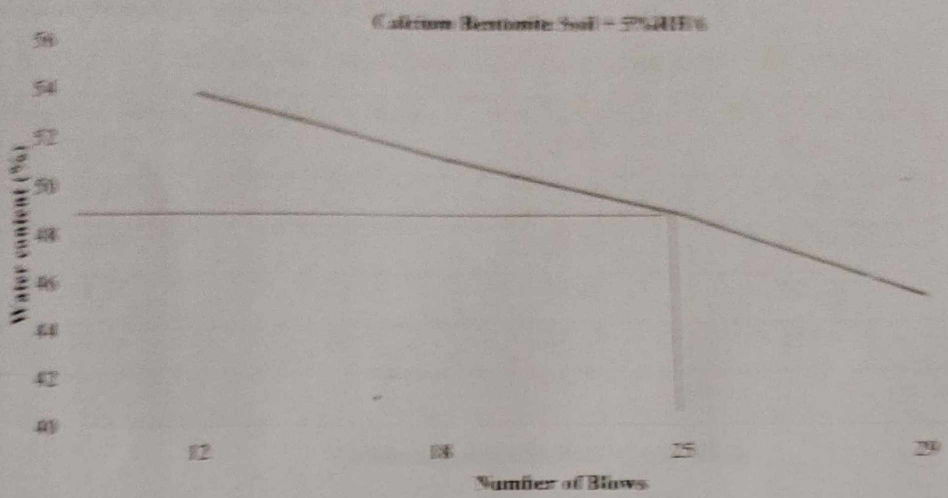
Weight of Blows(in gm)	Number of Blows	Wet Weight (in gm)	Dry Weight (in gm)	Water content (%)
13.85	12	32.96	25.58	49.72
14.25	19	34.32	26.78	47.81
14.36	24	36.01	28.37	46.11
14.21	31	29.14	23.95	43.75



Calcium Bentonite Soil + 5%RHA

Table 16. Liquid limit Calcium Bentonite Soil + 10% RHA

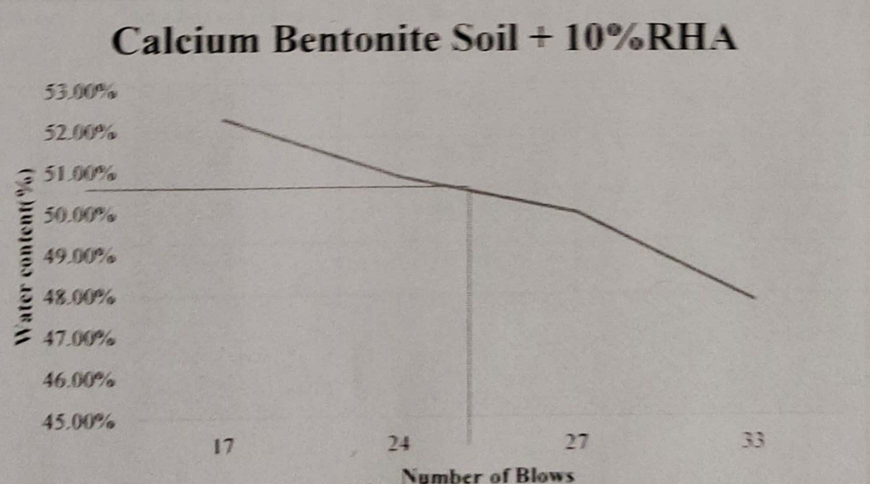
Weight of Blows(in gm)	Number of Blows	Wet Weight (in gm)	Dry Weight (in gm)	Water content (%)
14.47	12	20.72	18.56	53.86
14.36	18	32.31	26.86	51.27
14.13	25	29.97	24.36	48.87
13.96	29	25.11	21.46	45.39



Calcium Bentonite Soil + 10%RHA

Table 17. Liquid limit Calcium Bentonite Soil + 10% RHA

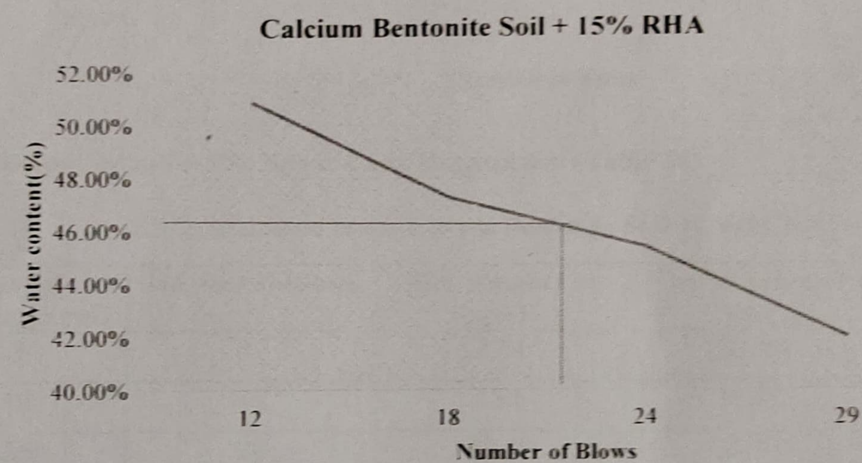
Weight of Blows(in gm)	Number of Blows	Wet Weight (in gm)	Dry Weight (in gm)	Water content (%)
14.35	17	47.31	35.63	52.26%
13.89	24	49.71	37.43	50.84%
14.01	27	46.57	35.84	49.97%
43.13	33	33.84	33.84	47.82%



Calcium Bentonite Soil + 15%RHA

Table 18. Liquid limit Calcium Bentonite Soil + 15% RHA

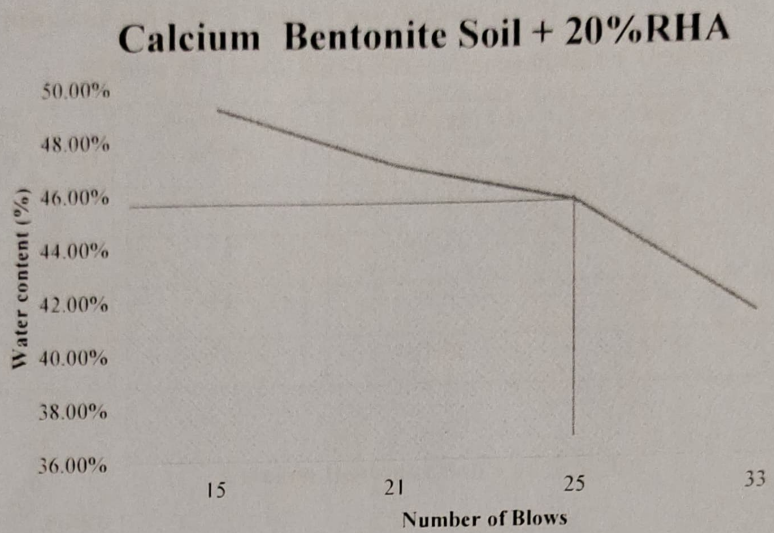
Weight of Blows(in gm)	Number of Blows	Wet Weight (in gm)	Dry Weight (in gm)	Water content (%)
13.85	11	32.96	25.58	50.87
14.25	17	34.32	26.78	47.25
14.36	26	36.01	28.37	45.36
14.21	30	29.14	23.95	41.98



Calcium Bentonite Soil + 20%RHA

Table 19. Liquid limit Calcium Bentonite Soil + 20% RHA

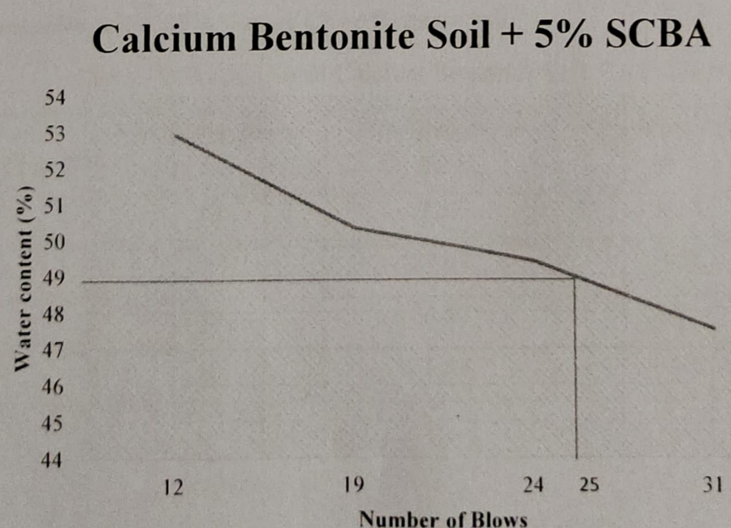
weight of Blows(in gm)	Number of Blows	Wet Weight (in gm)	Dry Weight (in gm)	Water content (%)
14.79	15	29.4	24.1	49.14%
14.11	21	26.73	22.28	46.99%
14	25	28.59	23.52	45.59%
14.24	33	30.54	25	41.32%



Calcium Bentonite soil + 5% Sugar Cane Bagasse ash (Table 20)

Table 20. Liquid limit Calcium Bentonite Soil + 5% SCBA

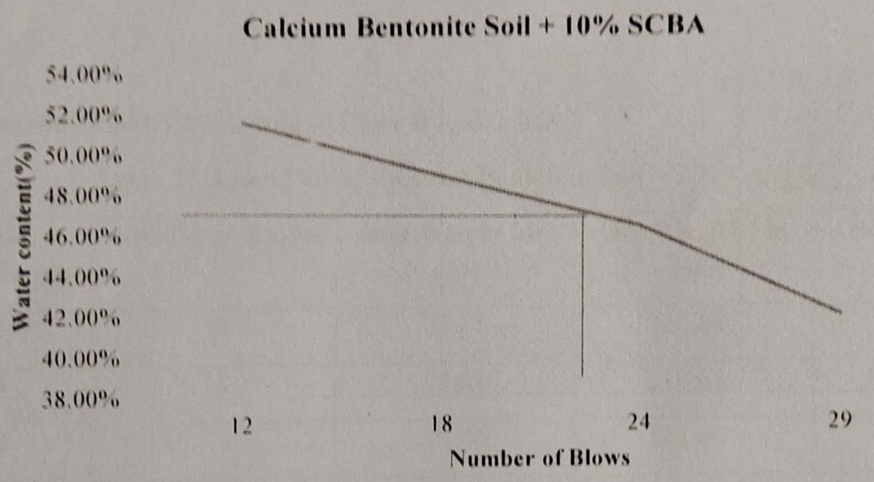
Weight of Container(in gm)	Number of Blows	Wet Weight (in gm)	Dry Weight (in gm)	Water content (%)
14.3	12	27.4	20.22	52.91
14.02	19	23.6	19.42	50.32
14.35	24	28.49	25.32	49.39
14.21	31	25.44	22.45	47.51



Calcium Bentonite soil + 10% Sugar Cane Bagasse ash

Table 21. Liquid limit Calcium Bentonite Soil + 10% SCBA

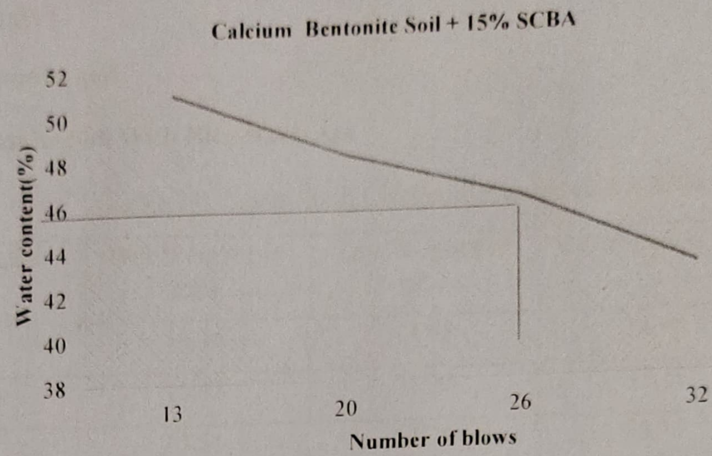
Weight of Container(in gm)	Number of Blows	Wet Weight (in gm)	Dry Weight (in gm)	Water content (%)
14.73	15	31.66	25.98	51.54
14.35	18	35.19	28.18	48.88
14.07	24	33.1	23.04	46.36
14.39	35	27.18	25.74	41.89



Calcium Bentonite soil + 15% Sugar Cane Bagasse ash

Table 22. Liquid limit Calcium Bentonite Soil + 15% SCBA

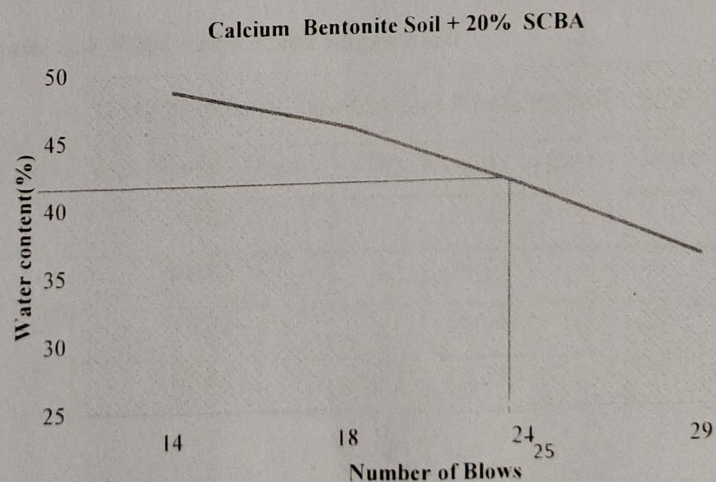
Weight of Container(in gm)	Number of Blows	Wet Weight (in gm)	Dry Weight (in gm)	Water content (%)
14.73	13	22.7	19.62	50.96
14.02	20	27.69	23.04	48.15
14.3	26	26.83	22.54	46.18
14.29	32	31.86	25.85	42.87



Calcium Bentonite soil + 20% Sugar Cane Bagasse ash

Table 23. Liquid limit Calcium Bentonite Soil + 20% SCBA

Weight of Container(in gm)	Number of Blows	Wet Weight (in gm)	Dry Weight (in gm)	Water content (%)
14.45	14	23.81	20.84	48.59
14.36	18	21.81	19.61	45.78
14.29	24	25.36	22.03	41.25
14.32	29	21.13	18.91	35.94



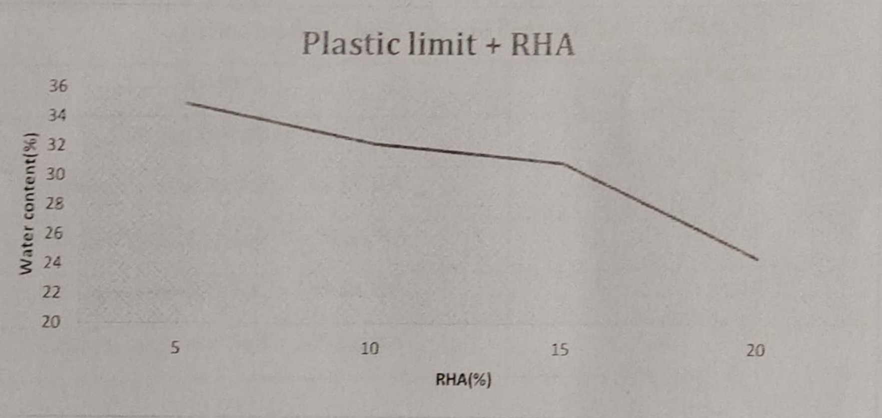
PLASTIC LIMIT

Calcium Bentonite soil

Sodium Bentonite Soil With Rice Husk Ash

Table 24. Plastic limit Calcium Bentonite Soil + RHA

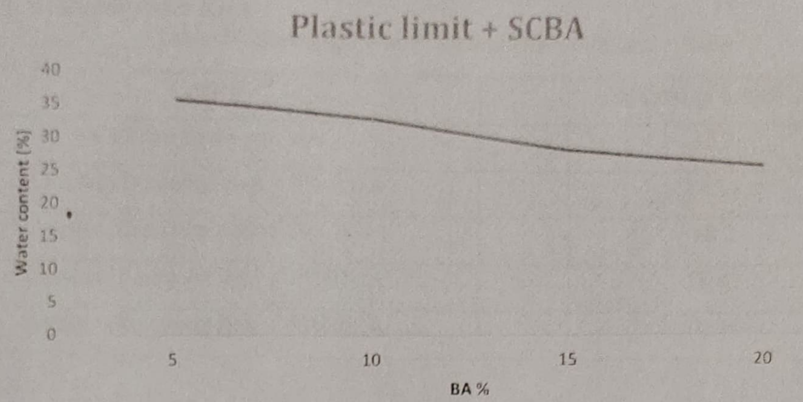
Empty Beaker (gm)	Wet Weight (in gm)	Dry Weight (in gm)	Water content (%)	RHA %
14.52	15.15	14.65	34.98	5
1422	15.42	14.39	32.21	10
14.32	15.51	14.78	30.93	15
14.25	15.98	15.23	24.42	20



Sodium Bentonite Soil With Sugar Cane Bagasse ash

Table 25. Plastic limit Calcium Bentonite Soil + SCBA

EmptyBeaker(gm)	Wet Weight (in gm)	Dry Weight (in gm)	Water content (%)	SCBA %
14.25	18.64	17.52	35.52	5
14.33	16.91	16.22	32.95	10
14.37	17.98	16.54	28.27	15
14.31	16.88	15.33	25.72	20

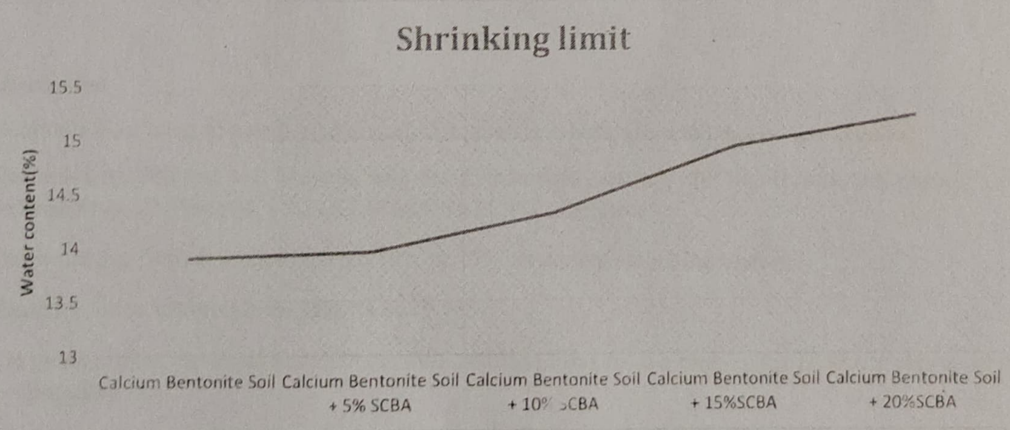


SHRINKING LIMIT

Sodium Bentonite soil + SCBA

Table 26.Shrinkage limit Calcium Bentonite Soil + SCBA

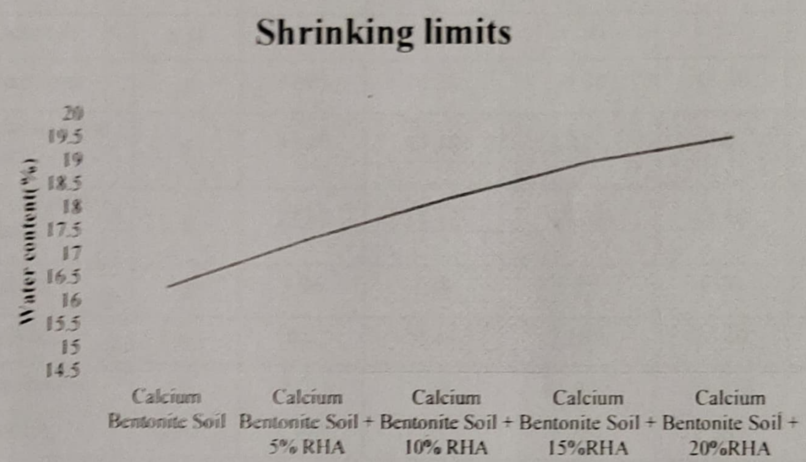
Content	Shrinking limits(%)
Calcium Bentonite Soil	13.9
Calcium Bentonite Soil + 5% SCBA	13.95
Calcium Bentonite Soil + 10% SCBA	14.31
Calcium Bentonite Soil + 15%SCBA	14.93
Calcium Bentonite Soil + 20%SCBA	15.22



Sodium Bentonite soil + RHA

Table 27. Shrinkage limit Calcium Bentonite Soil + RHA

Content	Shrinking limits(%)
Calcium Bentonite Soil	16.3
Calcium Bentonite Soil + 5% RHA	17.34
Calcium Bentonite Soil + 10% RHA	18.2
Calcium Bentonite Soil + 15%RHA	18.97
Calcium Bentonite Soil + 20%RHA	19.45



Discussion

Bentonite Soil turns to a well graded material when rice husk ash and bagasse ash is added.

The index qualities of soil blended with waste materials , namely the liquid limit and plastic limit. decreasefrom 52.9% to 36.31% and 34.28% to 25.4% respectively

The shrinkage limit is Increases from 16% to 19% on adding stablising material.

Plasticity index lowered from 18.62% to 10.91%

The index properties reveal that the bentonite soiltransitions from a high compressibility clay to a low compressible clay

The degree of expansiveness changes from very high to low in the stabilization of bentonite soil withwaste materials.

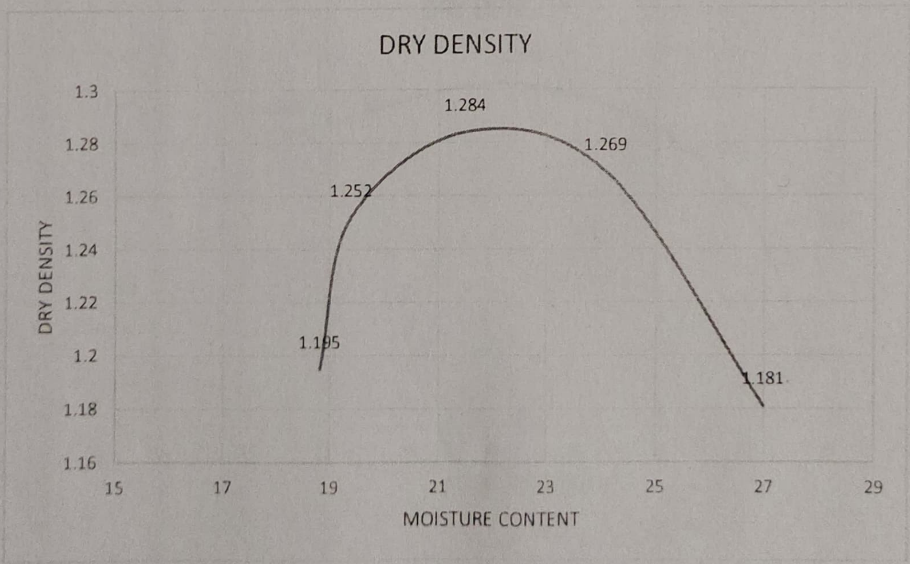
Thus Bentonite soil can be used in pavement and building construction.

Compaction

SODIUM BENTONITE

Table 29. Compaction of Sodium bentonite

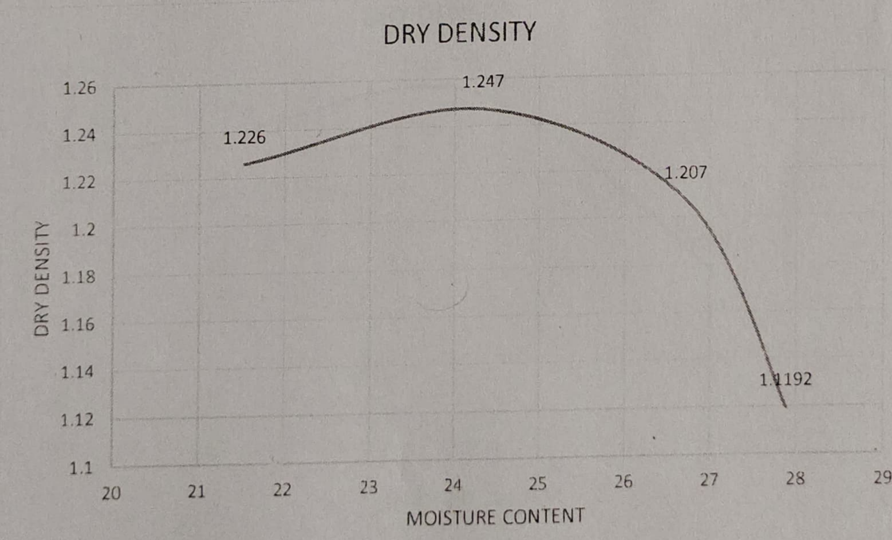
Particulars	Unit	Sample1	Sample2	Sample3	Sample4	Sample5
MouldWt.+ CompactedSoil	g	5490	5565	5630	5645	5570
MouldWt.	g	4070	4070	4070	4070	4070
CompactedSoilWt.	g	1420	1495	1560	1575	1500
VolumeofMould	cc	1000	1000	1000	1000	1000
WetDensity	g/cc	1.42	1.495	1.56	1.575	1.5
Wt.ofContainer	g	14.01	14.28	14.18	14.00	14.15
Wt.ofContainer+Wet Soil	g	36.49	43.10	42	48	30.76
Wt.ofContainer+Dry Soil	g	32.93	38.42	37.08	41.40	27.23
WaterWt.	g	3.96	4.68	4.92	6.60	3.53
DryWt.	g	18.92	24.14	22.90	27.40	13.08
MoistureContent	%	18.816	19.387	21.485	24.088	26.988
DryDensity	g/cc	1.195	1.252	1.284	1.269	1.181



SODIUM BENTONITE + 5 % SCBA

Table 30. Compaction of Sodium bentonite + 5% SCBA

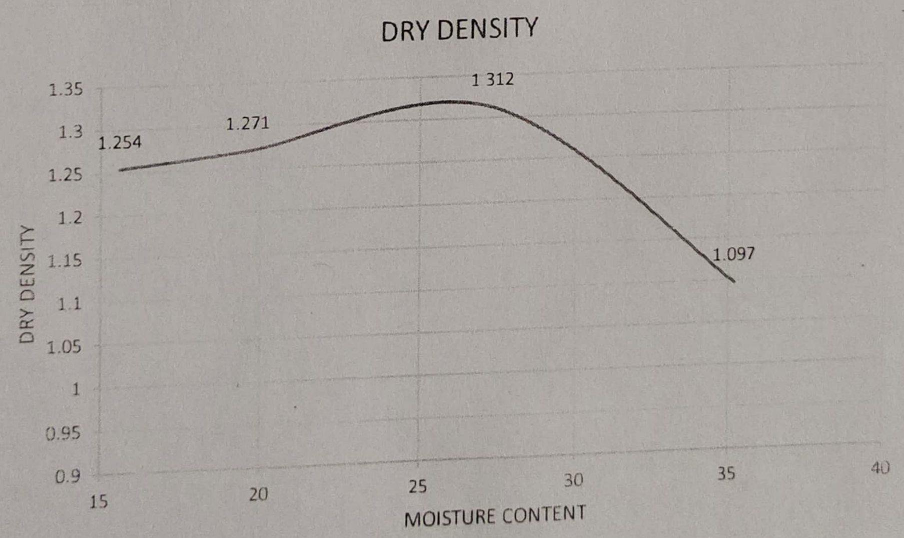
Particulars	**Unit**	**Sample1**	**Sample2**	**Sample3**	**Sample4**
Mould Wt.+CompactedSoil	g	5560	5620	5600	5595
MouldWt.	g	4070	4070	4070	4070
CompactedSoilWt.	g	1490	1550	1530	1525
VolumeofMould	cc	1000	1000	1000	1000
WetDensity	g/cc	1.49	1.55	1.53	1.525
Wt.ofContainer	g	14.27	14.25	14.07	14.37
Wt.ofContainer+Wet Soil	g	26.86	18.90	34.75	32.30
Wt. of Container + DrySoil	g	24.63	17.99	30.39	28.39
WaterWt.	g	2.23	0.91	4.36	3.91
DryWt.	g	10.36	3.74	16.32	14.02
MoistureContent	%	21.525	24.332	26.716	27.889
DryDensity	g/cc	1.226	1.247	1.207	1.192



SODIUM BENTONITE + 10% SCBA

Table 30. Compaction of Sodium bentonite + 10% SCBA

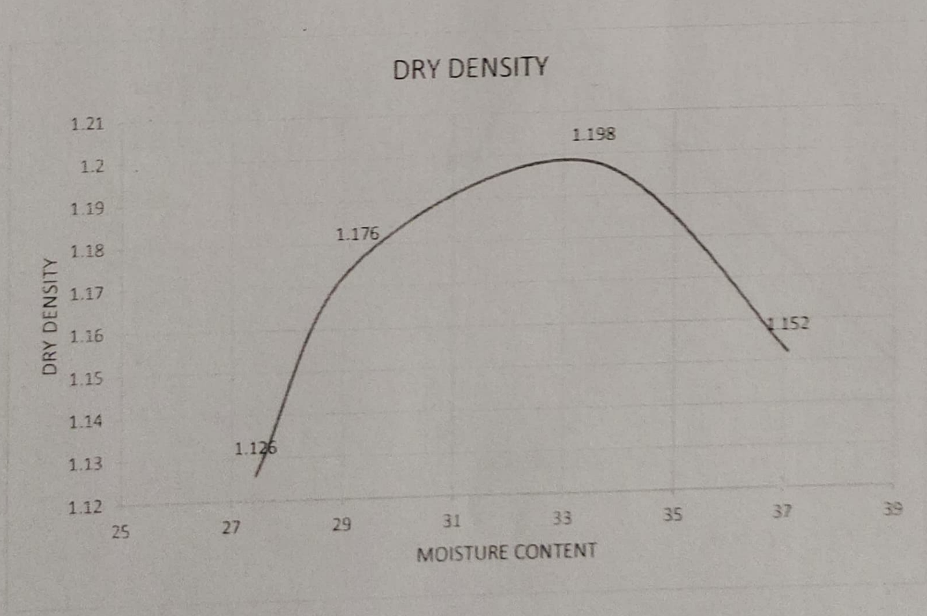
-Particulars	Unit	Sample1	Sample2	Sample3	Sample4
MouldWt.+ CompactedSoil	g	5520	5590	5740	5630
MouldWt.	g	4070	4070	4070	4070
CompactedSoilWt.	g	1450	1520	1670	1560
VolumeofMould	cc	1000	1000	1000	1000
WetDensity	g/cc	1.45	1.52	1.67	1.56
Wt.ofContainer	g	14.18	14.32	14.20	14.29
Wt.ofContainer+Wet Soil	g	20.41	23.35	21.70	21.30
Wt.ofContainer+Dry Soil	g	19.57	21.87	20.09	20.20
WaterWt.	g	0.84	1.48	1.61	1.1
DryWt.	g	5.39	7.55	5.89	5.91
MoistureContent	%	15.584	19.603	27.334	35.191
DryDensity	g/cc	1.254	1.271	1.312	1.097



SOIUM BENTONITE +15 % SCBA

Table 31. Compaction of Sodium bentonite +15% SCBA

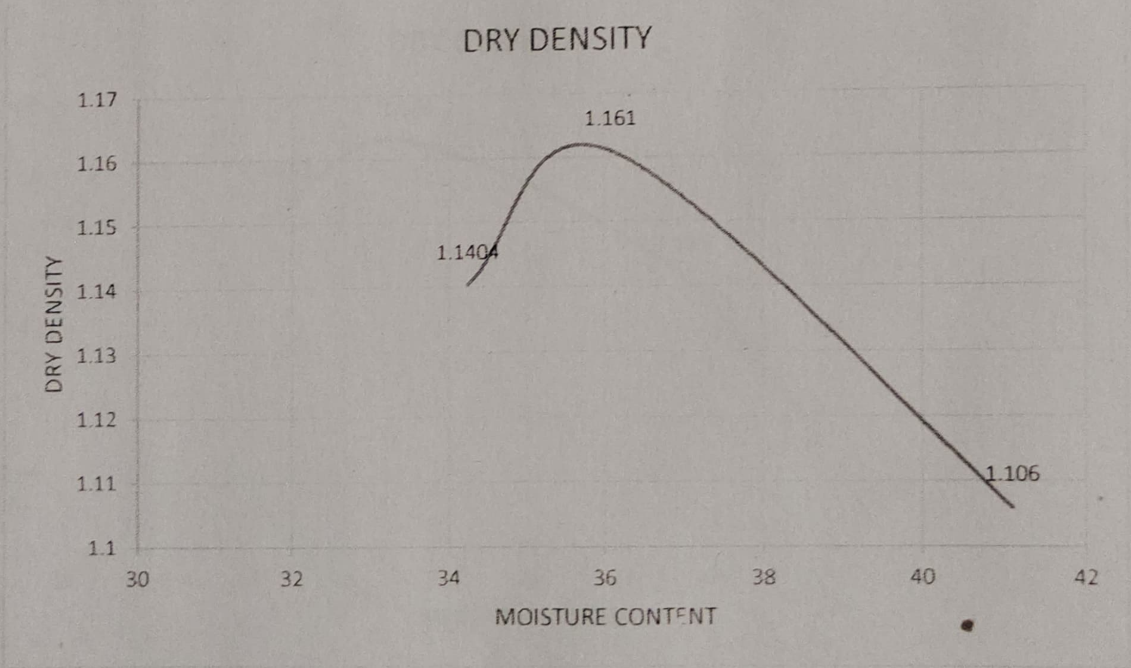
Particulars	Unit	Sample1	Sample2	Sample3	Sample4
MouldWt.+ CompactedSoil	g	5500	5590	5670	5650
MouldWt.	g	4070	4070	4070	4070
CompactedSoilWt.	g	1430	1520	1600	1580
VolumeofMould	cc	1000	1000	1000	1000
WetDensity	g/cc	1.43	1.52	1.6	1.58
Wt.ofContainer	g	14.45	14.18	14.36	13.82
Wt.ofContainer+Wet Soil	g	21.37	24.56	29.53	38.92
Container + DrySoil	g	19.88	22.21	25.72	32.13
WaterWt.	g	1.49	2.35	3.81	6.79
DryWt.	g	5.44	8.03	11.36	18.31
MoistureContent	%	27.440	29.265	33.539	37.084
DryDensity	g/cc	1.122	1.176	1.198	1.152



SODIUM BENTONITE + 20% SCBA

Table 32. Compaction of Sodium bentonite + 20% SCBA

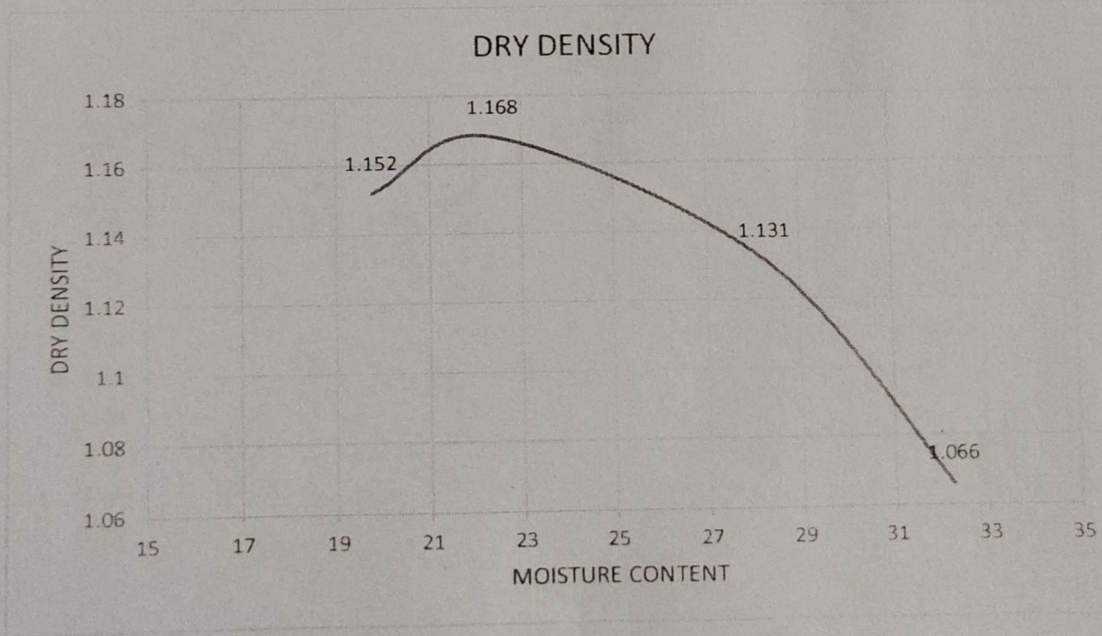
Particulars	Unit	Sample1	Sample2	Sample3
MouldWt. +CompactedSoil	g	5600	5650	5630
MouldWt.	g	4070	4070	4070
CompactedSoilWt.	g	1530	1580	1560
VolumeofMould	cc	1000	1000	1000
WetDensity	g/cc	1.53	1.58	1.56
Wt.ofContainer	g	14.47	13.96	14.09
Wt.ofContainer+WetSoil	g	29.21	49.37	27.65
Wt.ofContainer+ DrySoil	g	25.45	39.98	23.70
WaterWt.	g	3.76	9.39	9.95
DryWt.	g	10.98	26.02	9.67
MoistureContent	%	34.244	36.088	41.103
DryDensity	g/cc	1.1404	1.161	1.106



SODIUM BENTONITE + 5% RHA

Table 33. Compaction of Sodium bentonite + 5% RHA

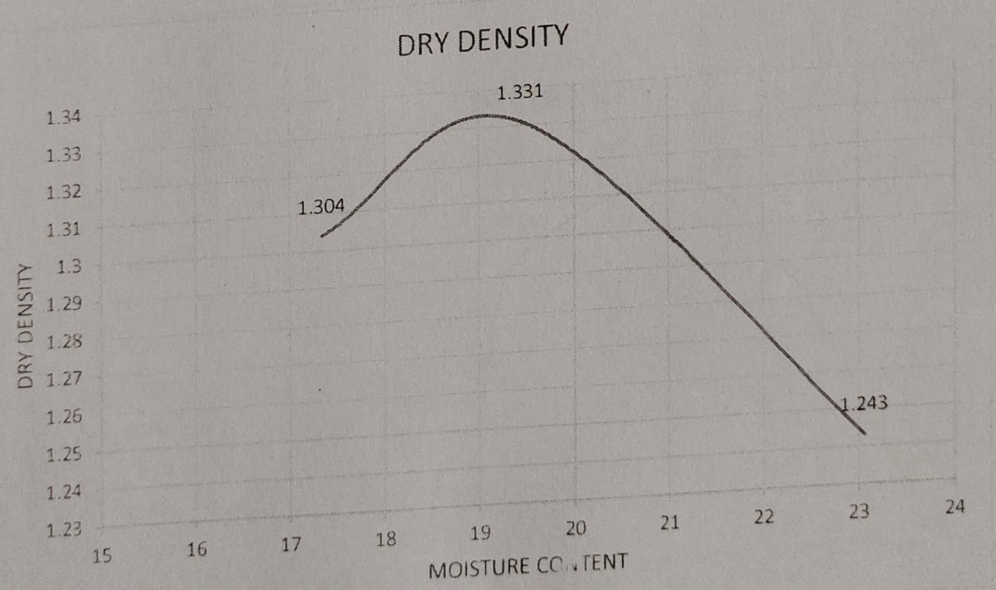
Particulars	Unit	Sample1	Sample2	Sample3	Sample4
MouldWt.+ CompactedSoil	g	5450	5500	5520	5480
MouldWt.	g	4070	4070	4070	4070
CompactedSoilWt.	g	1380	1430	1450	1410
VolumeofMould	cc	1000	1000	1000	1000
WetDensity	g/cc	1.38	1.43	1.45	1.41
Wt.ofContainer	g	14.19	14.25	14.17	14.13
Wt.ofContainer+Wet Soil	g	44.44	31.20	31.87	46.73
Wt.ofContainer+Dry Soil	g	39.45	28.10	27.97	38.78
WaterWt..	g	4.99	3.1	3.9	7.95
DryWt.	g	25.26	13.85	13.8	24.65
MoistureContent	%	19.754	22.383	28.261	32.252
DryDensity	g/cc	1.152	1.168	1.131	1.066



SODIUM BENTONITE + 10 % RHA

Table 34. Compaction of Sodium bentonite + 10% RHA

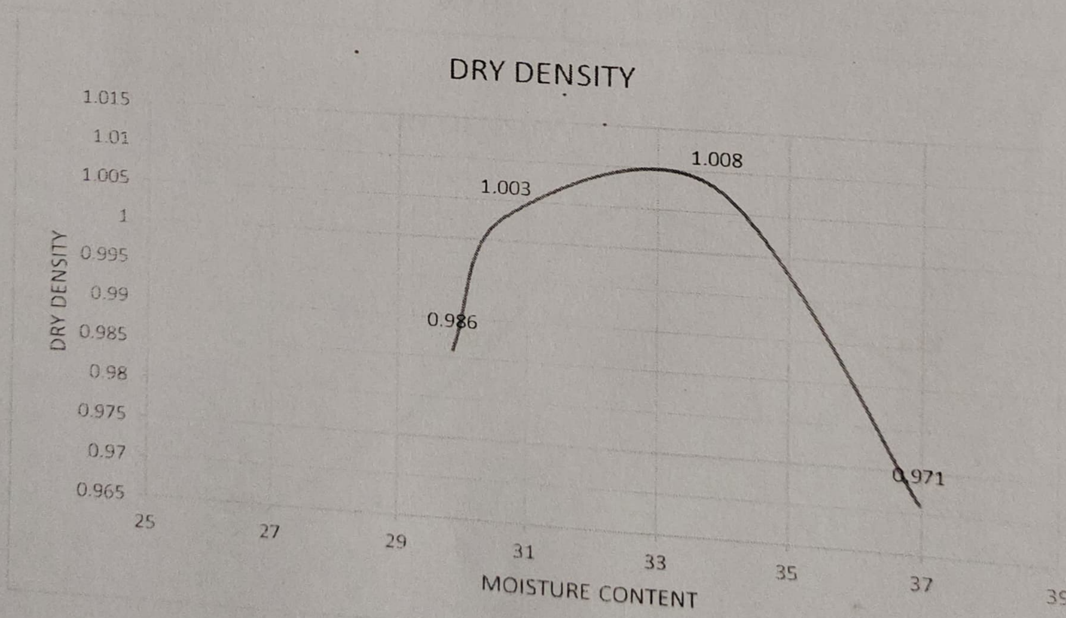
Particulars	Unit	Sample1	Sample2	Sample3
MouldWt.+Compacted Soil	g	5600	5660	5600
MouldWt.	g	4070	4070	4070
CompactedSoilWt.	g	1530	1590	1530
VolumeofMould	cc	1000	1000	1000
WetDensity	g/cc	1.53	1.59	1.53
Wt.ofContainer	g	14.30	14.26	14.28
Wt.ofContainer+WetSoil	g	33.93	45.22	41.66
Wt.ofContainer+ DrySoil	g	31.03	40.18	36.53
WaterWt.	g	2.9	5.04	5.13
DryWt.	g	16.73	25.92	22.25
MoistureContent	%	17.334	19.444	23.056
DryDensity	g/cc	1.304	1.331	1.243



SODIUM BENTONITE + 15% RHA

Table 35. Compaction of Sodium bentonite + 15% RHA

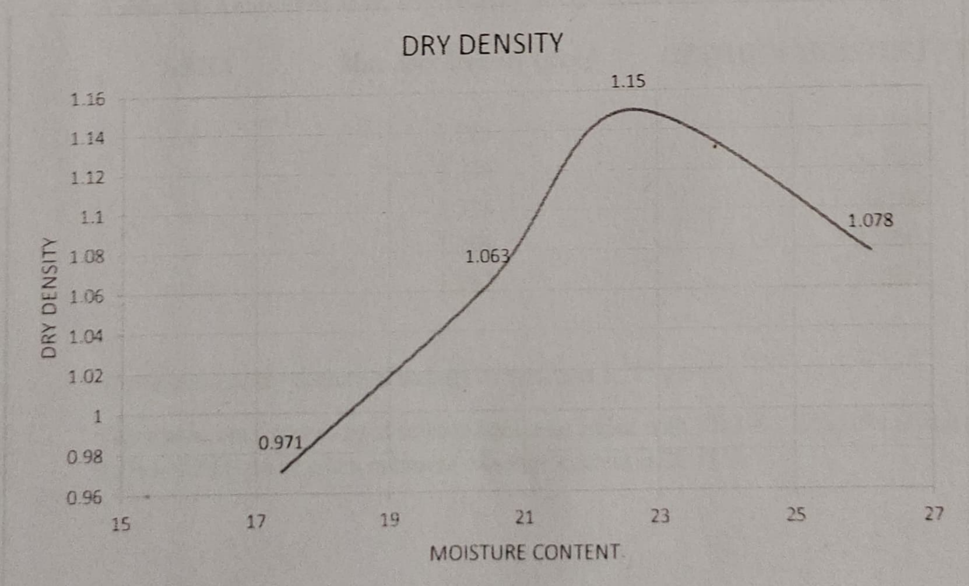
Particulars	Unit	Sample1	Sample2	Sample3	Sample4
Mould Wt.+CompactedSoil	g	5350	5380	5420	5400
MouldWt.	g	4070	4070	4070	4070
CompactedSoilWt.	g	1280	1310	1350	1330
VolumeofMould	cc	1000	1000	1000	1000
WetDensity	g/cc	1.28	1.31	1.35	1.33
Wt.ofContainer	g	14.43	14.2	14.26	13.96
of Container +WetSoil	g	30.26	33.67	30.69	32.34
of Container +DrySoil	g	26.62	29.1	26.53	27.38
WaterWt.	g	3.64	4.57	4.16	4.96
DryWt.	g	12.19	14.9	12.27	13.42
MoistureContent	%	29.861	30.671	33.904	36.960
DryDensity	g/cc	0.986	1.003	1.008	0.971



SODIUM BENTONITE + 20% RHA

Table 36. Compaction of Sodium bentonite + 20% RHA

Particulars	Unit	Sample1	Sample2	Sample3	Sample4
Mould Wt.+CompactedSoil	g	5210	5350	5480	5430
MouldWt.	g	4070	4070	4070	4070
CompactedSoilWt.	g	1140	1280	1410	1360
VolumeofMould	cc	1000	1000	1000	1000
WetDensity	g/cc	1.14	1.28	1.41	1.36
Wt.ofContainer	g	14.17	14.56	14.34	14.09
ofContainer+WetSoil	g	36.20	37.87	30.03	32.10
f Container + DrySoil	g	32.94	33.91	27.14	28.37
WaterWt.	g	3.26	3.96	2.89	3.73
DryWt.	g	18.77	19.35	12.80	14.28
MoistureContent	%	17.368	20.465	22.578	26.120
DryDensity	g/cc	0.971	1.063	1.150	1.078



DISCUSSION

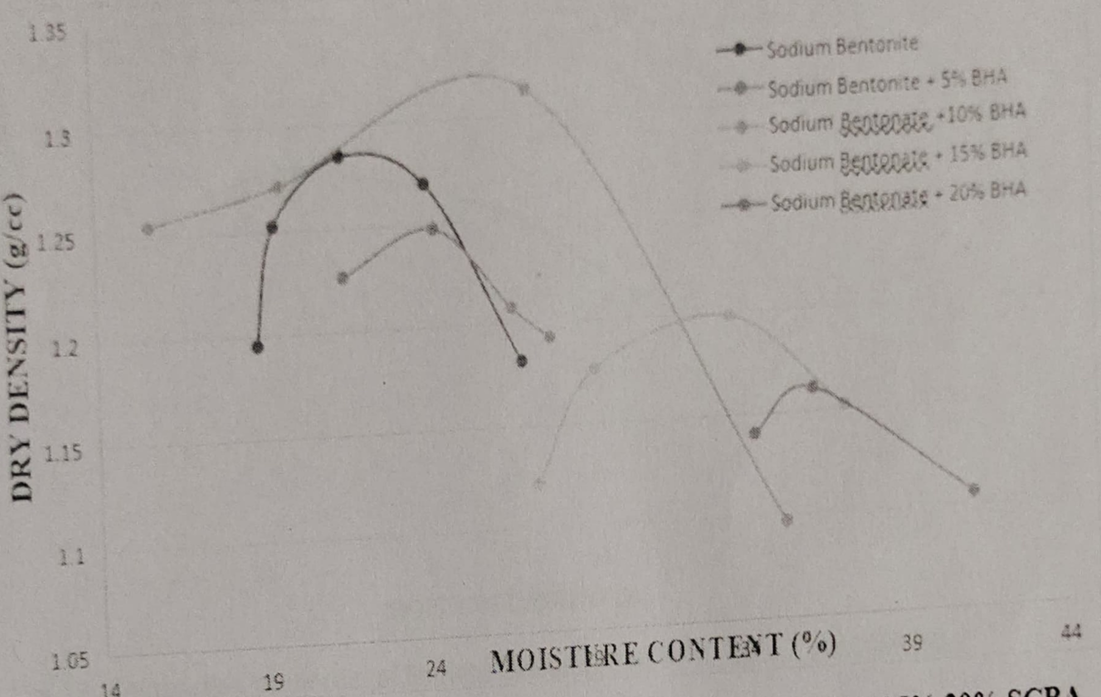


Fig. 16: Compaction properties of Sodium Bentonite Soil + 5%, 10%, 15% 20% SCBA

Table: 14. Analysis of Max. Dry Density at Optimum Moisture Content at different %SCBA

%BHA	Max. Dry Density (g/cc)	OPTIMUM MOISTURE CONTENT (%)
0	1.285	22.235
5	1.248	24.089
10	1.323	26.140
15	1.199	33.097
20	1.162	35.681

The maximum dry density of sodium bentonite is 1.285 gm/cc.

The maximum dry der ity of sodium bentonite added with 5%,10%,15%,20% SCGA is across 10% is 1.323 gm/cc when optimum moisture content is 26.41 %.

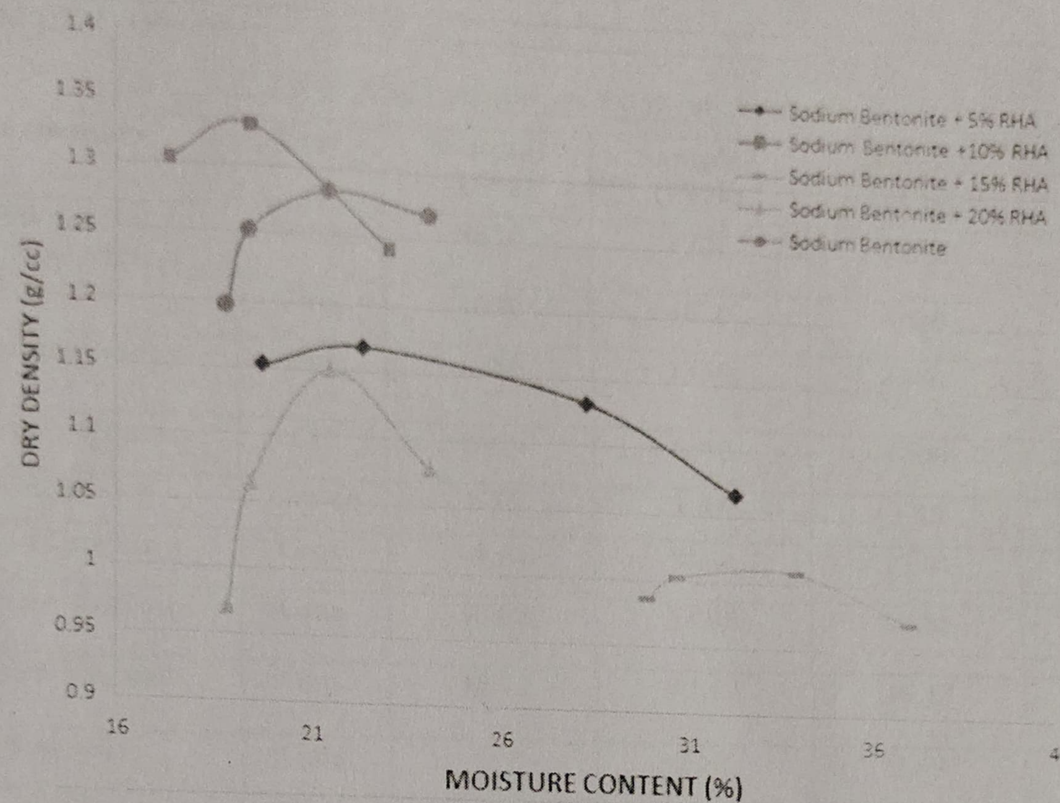


Fig. 17: Compaction properties of Sodium Bentonite Soil + 5%, 10%, 15% 20% RHA

Table: 14. Analysis of Max. Dry Density at Optimum Moisture Content at different %RHA

%RHA	Max. Dry Density (g/cc)	OPTIMUM MOISTURE CONTENT (%)
0	1.285	22.235
5	1.169	21.872
10	1.332	19.001
15	1.010	33.000
20	1.150	22.578

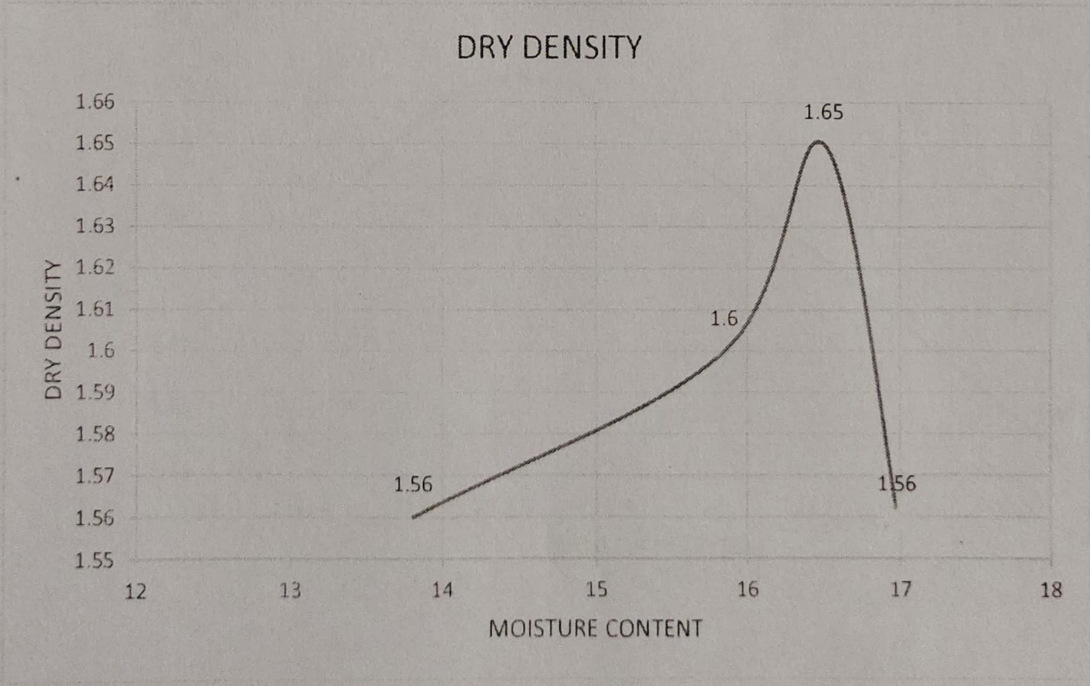
The maximum dry density of sodium bentonite is 1.285 gm/cc.

The maximum dry density of sodium bentonite added with 5%,10%,15%,20% RHA was across 10% is 1.332 gm/cc when optimum moisture content is 19.001 %.

CALCIUM BENTONITE

Table 37. Compaction of Calcium bentonite

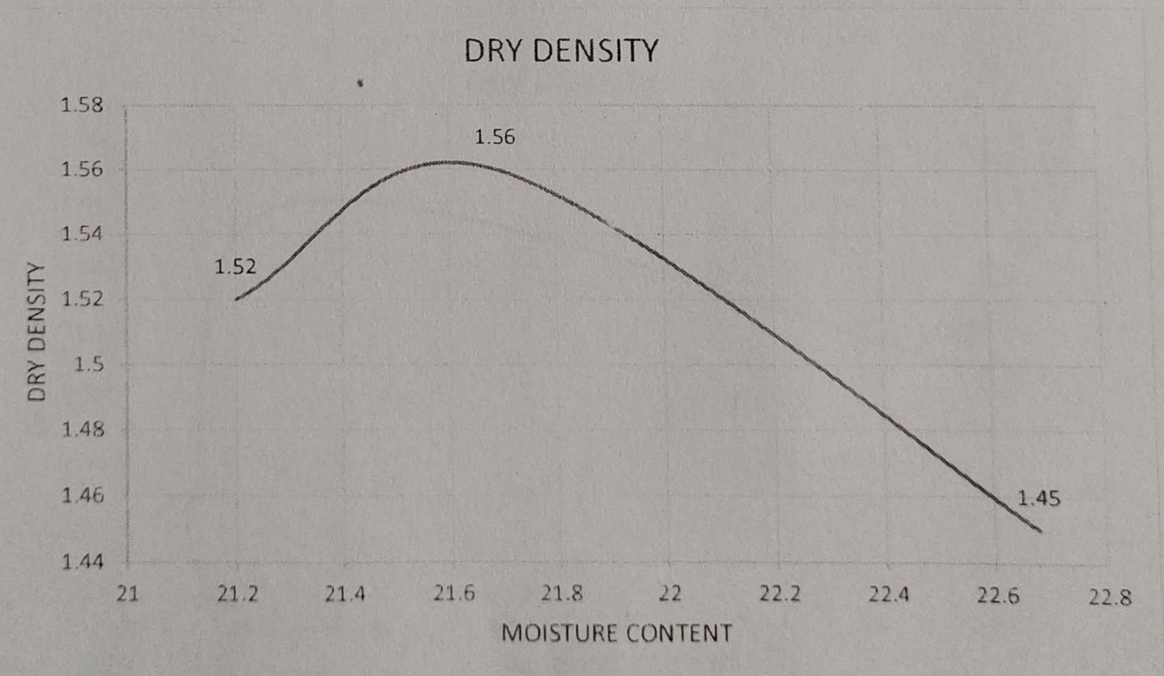
Particulars	Unit	Sample1 (15%)	Sample2 (18%)	Sample3 (21%)	Sample4 (24%)
Mould Wt. +CompactedSoil	Gms.	5850	5920	5950	5900
MouldWt.	Gms.	4070	4070	4070	4070
CompactedSoilWt.	Gms.	1780	1850	1880	1830
VolumeofMould	CC	1000	1000	1000	1000
WetDensity	Gm/cc	1.76	1.85	1.88	1.63
Wt. of Container	Gms.	14.36	14.44	13.81	14.16
fContainer+WetSoil	Gms.	30.02	34.98	39.86	39.24
fContainer+DrySoil	Gms.	28.12	32.17	36.17	35.60
WaterWt.	Gms.	1.9	2.81	3.69	3.64
DryWt.	Gms.	13.76	17.73	22.36	21.61
MoistureContent	%	13.808	15.848	16.502	16.978
DryDensity	Gm/cc	1.56	1.60	1.65	1.56



CALCIUM BENTONITE + 5% RHA **(Table 38)**

Table 38. Compaction of Calcium bentonite + 10% RHA

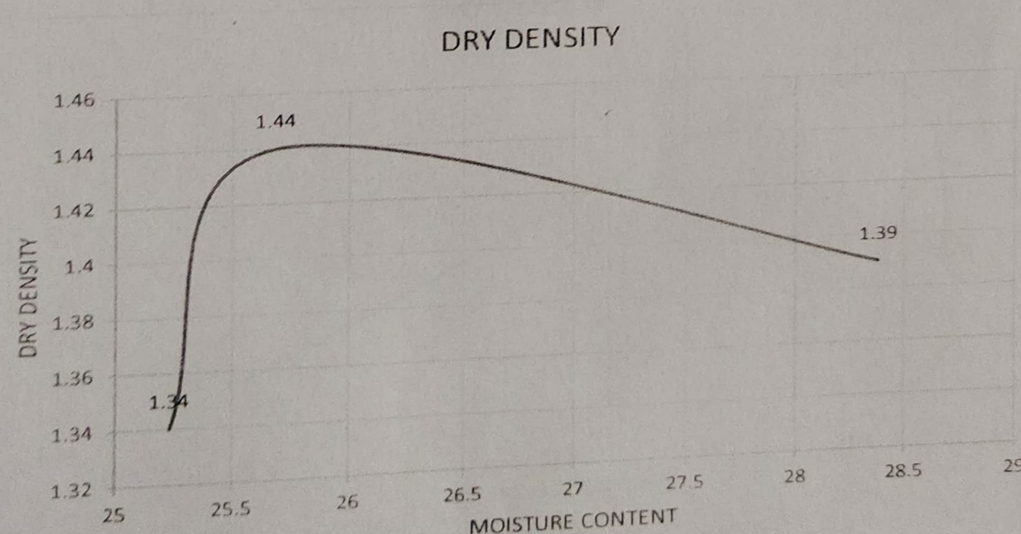
Particulars	**Unit**	**Sample1 (18%)**	**Sample2 (21%)**	**Sample3 (24%)**
MouldWt .+ CompactedSoil	Gms.	7330	7450	7380
MouldWt.	Gms.	5520	5520	5520
CompactedSoilWt.	Gms.	1810	1930	1660
VolumeofMould	CC	1000	1000	1000
WetDensity	Gm/cc	1.61	1.93	1.86
Wt. of Container	Gms.	14.340	14.090	13.470
Wt.ofContainer+WetSoil	Gms.	34.830	29.420	28.130
Wt. of Container+ Dry Soil	Gms.	31.230	26.670	25.420
WaterWt.	Gms.	3.6	2.75	2.71
DryWt.	Gms.	14.43	12.56	11.95
MoistureContent	%	21.2	21.69	22.68
DryDensity	Gm/cc	1.45	1.56	1.52



CALCIUM BENTONITE + 10 % RHA

Table 39. Compaction of Calcium bentonite + 10% RHA

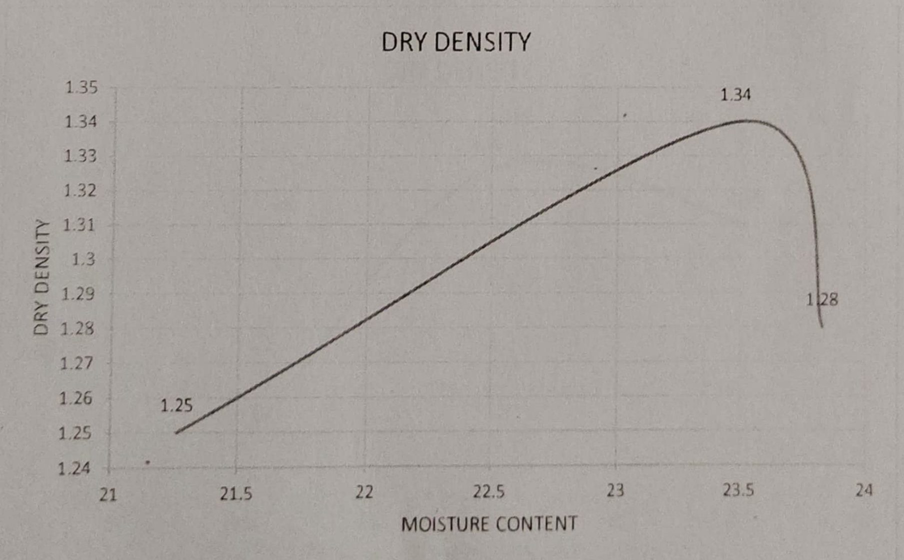
Particulars	Unit	Sample1 (18%)	Sample2 (21%)	Sample3 (24%)
MouldWt. +CompactedSoil	Gms.	7200	7330	7300
MouldWt.	Gms.	5520	5520	5520
CompactedSoilWt.	Gms.	1680	1810	1780
VolumeofMould	CC	1000	1000	1000
WetDensity	Gm/cc	1.68	1.81	1.78
Wt. of Container	Gms.	14.28	13.96	14.05
Wt.ofContainer+WetSoil	Gms.	24.90	34.51	39.47
Wt. of Container+ Dry Soil	Gms.	22.760	30.310	33.850
Water\ /t.	Gms.	2.14	4.20	5.62
DryWt.	Gms.	8.48	16.35	19.8
MoistureContent	%	25.23	25.68	28.38
DryDensity	Gm/cc	1.34	1.44	1.39



CALCIUM BENTONITE + 15% RHA(**Table 40**)

Table 40. Compaction of Calcium bentonite + 10% RHA

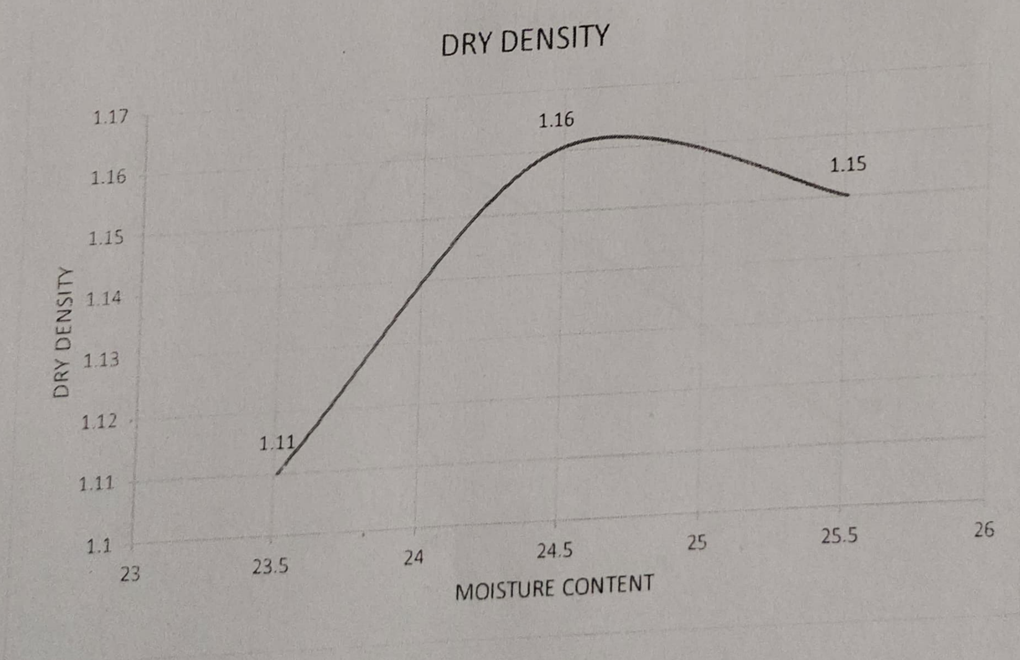
Particulars	**Unit**	**Sample1 (15%)**	**Sample2 (18%)**	**Sample3 (21%)**
+CompactedSoil	Gms.	7030	7170	7100
MouldWt.	Gms.	5520	5520	5520
CompactedSoilWt.	Gms.	1510	1650	1560
VolumeofMould	CC	1000	1000	1000
WetDensity	Gm/cc	1.51	1.65	1.58
Wt. of Container	Gms.	14.020	14.530	14.440
Wt.ofContainer+WetSoil	Gms.	31.13	32.30	30.65
Wt. of Container+ Dry Soil	Gms.	28.13	28.92	27.52
WaterWt.	Gms.	3.0	3.36	3.12
DryWt.	Gms.	14.11	14.36	13.09
MoistureContent	%	21.26	23.48	23.83
DryDensity	Gm/cc	1.25	1.34	1.28



CALCIUM BENTONITE + 20% RHA

Table 41. Compaction of Calcium bentonite + 20% RHA

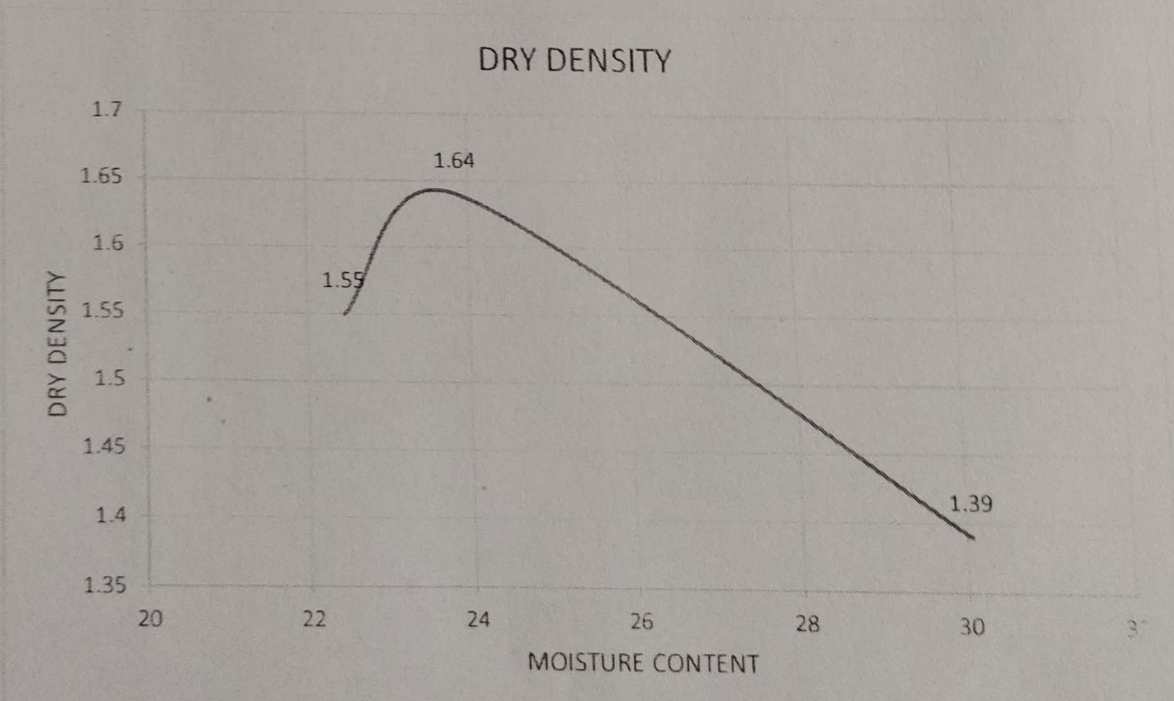
Particulars	Unit	Sample1 (15%)	Sample2(18%)	Sample3 (21%)
ouldWt.+CompactedSoil	Gms.	5465	5520	5500
MouldWt.	Gms.	4070	4070	4070
CompactedSoilWt.	Gms.	1395	1450	1430
VolumeofMould	CC	1000	1000	1000
WetDensity	Gm/cc	1.395	1.450	1.430
Wt. of Container	Gms.	14.81	14.35	13.21
Wt.ofContainer+WetSoil	Gms.	30.80	22.59	21.50
Wt. of Container+ Dry Soil	Gms.	27.55	20.92	19.90
WaterWt.	Gms.	3.25	1.62	1.60
DryWt.	Gms.	12.74	6.62	6.69
MoistureContent	%	23.91	24.47	25.51
DryDensity	Gm/cc	1.11	1.16	1.15



CALCIUM BENTONITE + 5% SCBA

Table 42. Compaction of Calcium bentonite + 5%SCBA

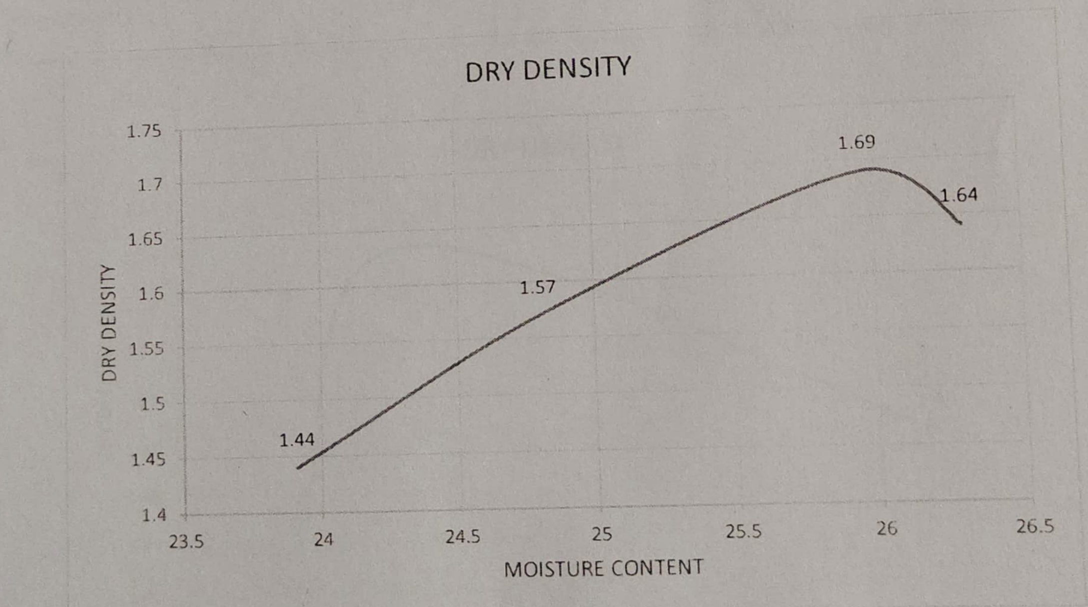
Particulars	Unit	Sample1 (18%)	Sample2 (21%)	Sample3 (24%)
+CompactedSoil	Gms.	7425	7550	7330
MouldWt.	Gms.	5520	5520	5520
CompactedSoilWt.	Gms.	1905	2030	1810
VolumeofMould	CC	1000	1000	1000
WetDensity	Gm/cc	1.9	2.03	1.81
Wt. of Container	Gms.	13.69	14.41	14.45
Wt.ofContainer+WetSoil	Gms.	34.70	42.19	48.63
Wt. of Container+ Dry Soil	Gms.	30.85	36.84	40.73
WaterWt.	Gms.	3.85	5.35	7.90
DryWt.	Gms.	17.16	22.43	26.28
MoistureContent	%	22.44	23.85	30.06
DryDensity	Gm/cc	1.55	1.64	1.39



CALCIUM BENTONITE + 10% SCBA

Table 43. Compaction of Calcium bentonite + 10% SCBA

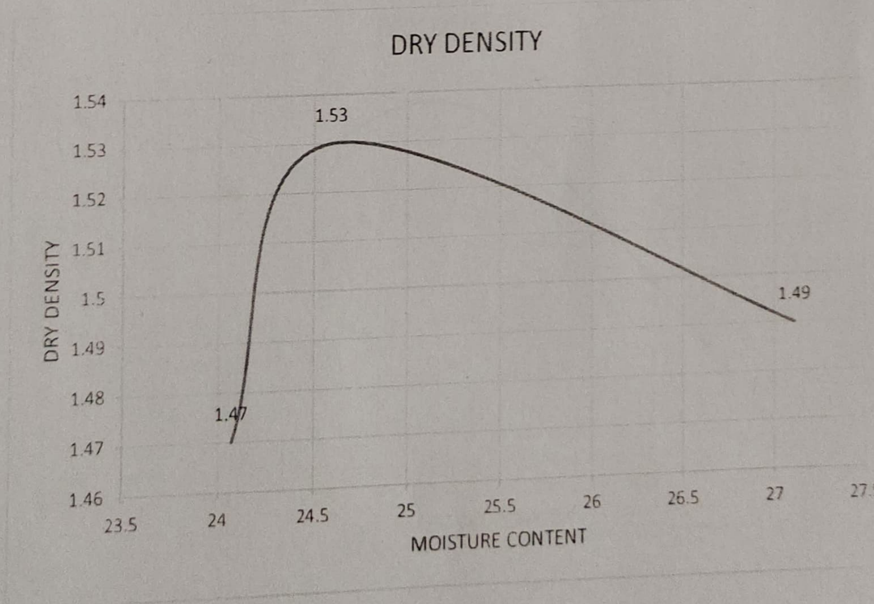
Particulars	Unit	Sample1(18 %)	Sample2 (21%)	Sample3 (24%)	Sample4 (27%)
Mould Wt. +CompactedSoil	Gms.	7300	7350	7330	7310
MouldWt.	Gms.	5520	5520	5520	5520
CompactedSoilWt.	Gms.	1780	1830	1810	1790
VolumeofMould	CC	1000	1000	1000	1000
WetDensity	Gm/cc	1.78	1.83	1.81	1.79
Wt. of Container	Gms.	14.25	14.08	14.03	14.04
tainer+WetSoil	Gms.	22.80	29.70	39.99	27.52
tainer+DrySoil	Gms.	21.15	26.70	34.64	24.85
WaterWt.	Gms.	1.65	3.00	5.35	2.67
DryWt.	Gms.	6.90	12.62	20.61	10.81
MoistureContent	%	23.91	24.8	25.96	26.3
DryDensity	Gm/cc	1.44	1.57	1.69	1.64



CALCIUM BENTONITE + 15 % SCBA

Table 44. Compaction of Calcium bentonite + 15% SCBA

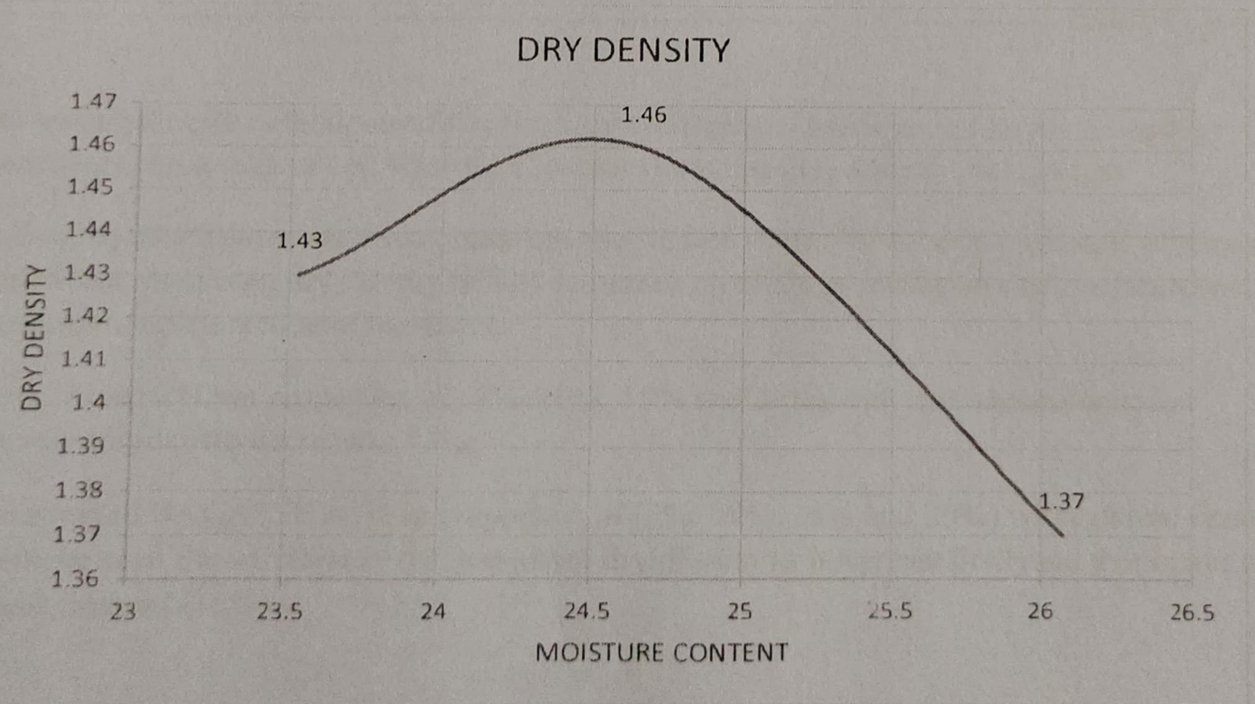
Particulars	Unit	Sample1 (18%)	Sample2 (21%)	Sample3 (24%)
+CompactedSoil	Gms.	5900	5980	5870
MouldWt.	Gms.	4070	4070	4070
CompactedSoilWt.	Gms.	1830	1910	1800
VolumeofMould	CC	1000	1000	1000
WetDensity	Gm/cc	1.83	1.91	1.80
Wt. of Container	Gms.	14.38	13.46	14.08
Wt.ofContainer+WetSoil	Gms.	33.40	46.20	37.01
Wt. of Container+ Dry Soil	Gms.	29.71	39.78	32.12
WaterWt.	Gms.	3.69	6.42	4.89
DryWt.	Gms.	15.33	26.32	18.04
MoistureContent	%	24.07	24.39	27.11
DryDensity	Gm/cc	1.47	1.53	1.49



CALCIUM BENTONITE + 20% SCBA **(Table 45)**

Table 45. Compaction of Calcium bentonite + 20 % SCBA

Particulars	**Unit**	**Sample1 (18%)**	**Sample2 (21%)**	**Sample3 (24%)**
CompactedSoil	Gms.	5640	5890	5800
MouldWt.	Gms.	4070	4070	4070
CompactedSoilWt.	Gms.	1770	1820	1730
VolumeofMould	CC	1000	1000	1000
WetDensity	Gm/cc	1.77	1.82	1.73
Wt. of Container	Gms.	13.28	14.52	14.36
Wt.ofContainer+WetSoil	Gms.	29.87	36.31	25.53
Wt. of Container+ Dry Soil	Gms.	26.71	32.00	23.22
WaterWt.	Gms.	3.16	4.31	2.31
DryWt.	Gms.	13.43	17.48	8.86
MoistureContent	%	23.53	24.66	26.07
DryDensity	Gm/cc	1.43	1.46	1.37



Discussion

Tableno.	Title	MDD(gm/cc)	OMC(%)
1	Compactionpropertiesof CalciumBentonite Soil	1.614	16.502
2	properties of Calcium Bentonite Soilwith 5 % RHA	1.560	21.69
3	Compaction properties of Calcium Bentonite Soil with 10 % RHA	1.440	25.688
4	Compaction properties of Calcium Bentonite Soilwith 15 % RHA	1.336	23.489
5	Compaction properties of Calcium Bentonite Soilwith 20 % RHA	1.16	24.47
6	Compaction properties of Calcium Bentonite Soilwith5 % Bagasseash	1.639	23.852
7	Compaction properties of Calcium Bentonite Soilwith10 % Bagasseash	1.69	25.96
8	Compaction properties of Calcium Bentonite Soilwith15 % Bagasseash	1.538	24.392
9	Compaction properties of Calcium Bentonite Soilwith20 % Bagasseash	1.460	24.657

Inorder tostudytheeffectofadditionofRiceHuskAshandBagasse Ashoncompressive strength at different proportions was mixed With the Calcium BentoniteClay tostudy the changes.

The following conclusions are drawn based on the studies made. On the basis ofresults obtained it is concluded that maximum dry density of soil decreases on mixingwithBagasse ash andalsoconcluded that maximum moisturecontent increases.

When we mixed RHAin proportion of (5%, 10%, 15% and 20%) with calciumbentonitesoil themaximumdrydensitydecreases.(15%)

When we mixed BAGASSE ASH in proportion of (5%, 10%, 15% and 20%) withcalcium bentonite soil, we have seen the variation in the maximum dry density as itdecreasefirstlyand thenincreasedand afterthendecreased.(15%)

DIFFERENTIAL SWELLING INDEX

Table 46. DIFFERENTIAL SWELLING INDEX

Sodium bentonite	In Kerosine (in gram)	In Water (In gram)	After 24 hours kerosine (In gram)	After 24 hours water (In gram)
0% RHA	10gm	10gm	10gm	36 gm
5 % RHA	10.05gm	10.05gm	10.05 gm	31.6 gm
10% RHA	10.1 gm	10.1 gm	10.1 gm	26.2 gm
15 % RHA	10.15 gm	10.15 gm	10.15 gm	27.6 gm
20% RHA	10.2 gm	10.20 gm	10.20 gm	28.7 gm
5 %SCBA	10.05gm	10.05gm	10.05gm	30.9gm
10%SCBA	10.1gm	10.1gm	10.1gm	27.8gm
15%SCBA	10.15gm	10.15gm	10.15gm	28.6gm
20%SCBA	10.2gm	10.2gm	10.20gm	29.1gm

Calcium bentonite	IN Kerosine (in gram)	IN Water (In gram)	After 24 hours kerosine (In gram)	After 24 hours water (In gram)
0% RHA	10gm	10gm	10gm	18 gm
5 % RHA	10.05gm	10.05gm	10.05 gm	17.1 gm
10% RHA	10.1 gm	10.1 gm	10.1 gm	16.8 gm
15 % RHA	10.15 gm	10.15 gm	10.15 gm	15.6gm
20% RHA	10.2 gm	10.20 gm	10.20 gm	16.2 gm
5 %SCBA	10.05gm	10.05gm	10.05gm	16.9gm
10%SCBA	10.1gm	10.1gm	10.1gm	16.4gm
15%SCBA	10.15gm	10.15gm	10.15gm	15.2gm
20%SCBA	10.2gm	10.2gm	10.20gm	15.8gm

UCS

CALCIUM BENTONITE

Observations Reading of specimen 1 at which the specimen deform due to compressive load.

L_0	Diameter	A_0	Deformation in length (ΔL)	Strain e=(ΔL /Lo)	Corrected area Ac= Ao /(1-e) mm^2)	Normal load (KN)	Compressive strength (KN/mm^2)
76.5 Mm	38mm	9132.609 mm^2	6.23mm	8.143%	9942.2026 mm^2	1.9131 KN	0.000149866 KN/mm^2

Reading of specimen 2 at which the specimen deform due to compressive load

L_0	Diameter	A_0	Deformation in length (ΔL)	Strain e=(ΔL /Lo)	Corrected area Ac= Ao /(1-e)(mm^2)	Normal load (KN)	Compressive strength (KN/mm^2)
77 mm	38mm	9192.030 mm^2	7mm	9.09%	10111.429 mm^2	2.375 KN	0.000234882 KN/mm^2

Average Compressive strength = (0.000149866 + 0.000234882)/2 = 0.000192237 KN/mm^2

CALCIUM BENTONITE + 15% RHA

Observations Reading of specimen 1 at which the specimen deform due to compressive load.

L_0	Diameter	A_0	Deformation in length (ΔL)	Strain e=(ΔL /Lo)	Corrected area Ac= Ao /(1-e)(mm^2)	Normal load (KN)	Compressive strength (KN/mm^2)
77 mm	38mm	9192.030 mm^2	7.6mm	10.13%	10228.140 mm^2	2.755 KN	0.000269354 KN/mm^2

Reading of specimen 2 at which the specimen deform due to compressive load

L_0	Diameter	A_0	Deformation in length (ΔL)	Strain e=(ΔL /Lo)	Corrected Area Ac= Ao /(1-e) mm^2)	Normal load (KN)	Compressive strength (KN/mm^2)
77 mm	38mm	9192.030 mm^2	8mm	10.3%	10293.7290 mm^2	3.10 KN	0.000301154 KN/mm^2

Average Compressive strength = (0.000269354 + 0.000301154)/2 = 0.000285254 KN/mm^2

CALCIUM BENTONITE + 15 % SCBA

L_0	Diameter	A_0	Deformation in length (ΔL)	Strain e=(ΔL /Lo)	Corrected area Ac= Ao /(1-e) mm^2)	Normal load (KN)	Compressive strength (KN/mm^2)
77 mm	38mm	9192.030 mm^2	7.4mm	9.610%	10169.2997 mm^2	2.8 KN	0.000275338 KN/mm^2

L_0	Diameter	A_0	Deformation in length (ΔL)	Strain e=(ΔL /Lo)	Corrected area Ac= Ao /(1-e) (mm^2)	Normal load (KN)	Compressive strength (KN/mm^2)
77 mm	38mm	9192.030 mm^2	8.1mm	10.5%	10270.4245 mm^2	3.4 KN	0.00033104 KN/mm^2

Average Compressive strength = (0.00027533 + 0.00033104)/2 = 0.00030185KN/mm^2

SODIUM BENTONITE

Observations Reading of specimen 1 at which the specimen deform due to compressive load

L_0	Diameter	A_0	Deformation in length (ΔL)	Strain e=(ΔL /Lo)	Corrected area Ac= Ao /(1-e)(mm^2)	Normal load (KN)	Compressive strength (KN/mm^2)
77 mm	38mm	9192.03 mm^2	8.7mm	11.29%	10363.208 mm^2	1.4285 KN	0.000137 KN/mm^2

Reading of specimen 2 at which the specimen deform due to compressive load

L_0	Diameter	A_0	Deformation in length (ΔL)	Strain e=(ΔL /Lo)	Corrected area Ac= Ao /(1-e)(mm^2)	Normal load (KN)	Compressive strength (KN/mm^2)
77 mm	38mm	9192.03 mm^2	7.8mm	10.12%	10228.426 mm^2	1.4176 KN	0.000138 KN/mm^2

Average Compressive strength = (0.000138 + 0.000137)/2 = 0.000138 KN/mm^2

SODIUM BENTONITE + 10 % RHA

L_0	Diameter	A_0	Deformation in length (ΔL)	Strain e=(ΔL /Lo)	Corrected area Ac= Ao /(1-e)(mm^2)	Normal load (KN)	Compressive strength (KN/mm^2)
77 mm	38mm	9192.03 mm^2	8.9mm	11.55%	10386.4745 mm^2	1.85 KN	0.000178 KN/mm^2

Average Compressive strength = (0.000178 + 0.0001964)/2 = 0.000187 KN/mm^2

L_0	Diameter	A_0	Deformation in length (ΔL)	Strain e=(ΔL /Lo)	Corrected area Ac= Ao /(1-e)(mm^2)	Normal load (KN)	Compressive strength (KN/mm^2)
77 mm	38mm	9192.03 mm^2	9.1mm	11.81%	10433.63 mm^2	2.05 KN	0 0001964 KN/mm^2

SODIUM BENTONITE + 10 SCBA

L_0	Diameter	A_0	Deformation in length (ΔL)	Strain e=(ΔL /Lo)	Corrected area Ac= Ao /(1-e)(mm^2)	Normal load (KN)	Compressive strength (KN/mm^2)
77 mm	38mm	9192.03 mm^2	8.8mm	11.42%	10386.474mm^2	1.95 KN	0.0001877 KN/mm^2

L_0	Diameter	A_0	Deformation in length (ΔL)	Strain e=(ΔL /Lo)	Corrected area Ac= Ao /(1-e)(mm^2)	Normal load (KN)	Compressive strength (KN/mm^2)
77 mm	38mm	9192.03 mm^2	8.7mm	11.29%	10363.055 mm^2	2.1 KN	0.0002026 KN/mm^2

Average Compressive strength = (0.0001877+ 0.0002026)/2 = 0.0001951 KN/mm^2

DIscussion

We seen in above table of sodium bentonite soil and calcium bentonite soil strength is increasing after adding of agriculture waste rice ash husk and sugar cane bagasse .

CBR (Sodium bentonite)

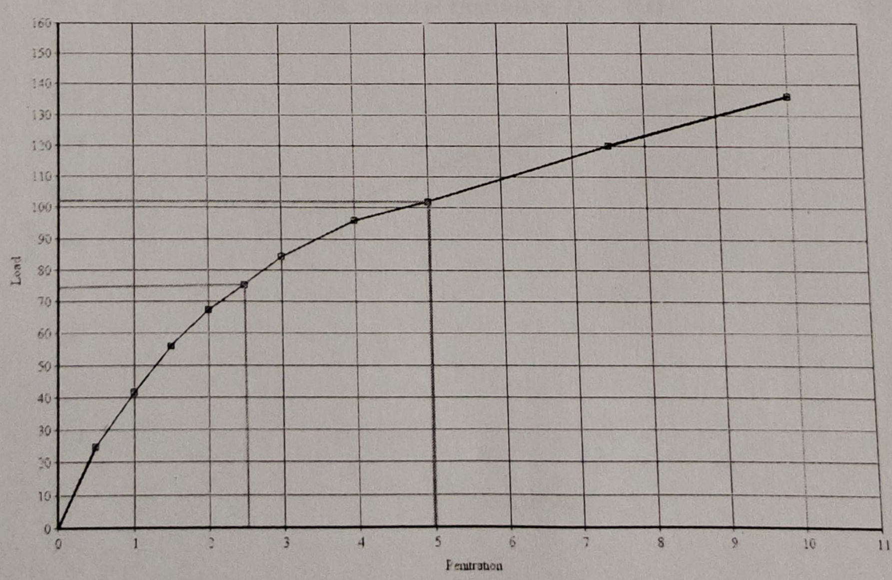
Table 47. CBR Sodium bentonite

S No.	Penetration (mm)	Proof ring reading (div)	Calibration factor	Load (kg)
1	0	0	-	-
2	0.5	19	1.295	24.7
3	1	32	1.295	41.44
4	1.5	43	1.295	55.68
5	2.0	52	1.295	67.34
6	2.5	58	1.295	75.11
7	3	65	1.295	84.17
8	4	74	1.295	95.83
9	5	83	1.226	101.706
10	7.5	98	1.226	120.145
11	10	111	1.226	136.09
12	12.5	120	1.226	147.12

CBR value corresponding to 2.5 mm penetration = (75.11/1370)*100 = 5.48 %

CBR value corresponding to 5mm penetration = (101.76/2055)*100 = 4.9 %

CBR value of the soil = 5.48 %



SODIUM BENTONITE + 10 % RHA

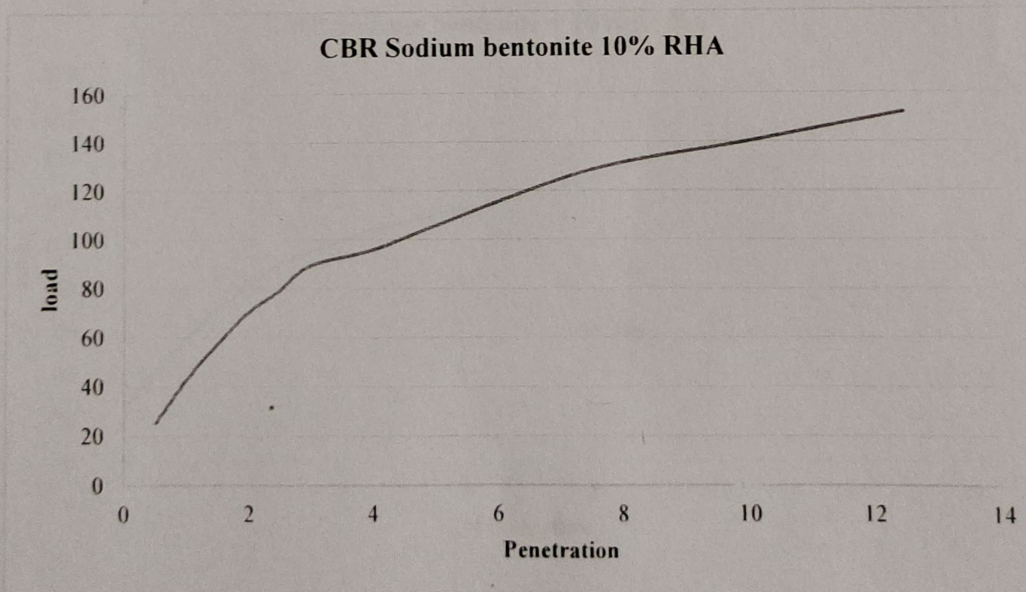
Table 48. CBR Sodium bentonite 10% RHA

S No.	Penetration (mm)	Proof ring reading (div)	Calibration factor	Load (kg)
1	0	0	-	-
2	0.5	20	1.295	25.2
3	1	33	1.295	43.25
4	1.5	45	1.295	57.35
5	2.0	54	1.295	70.54
6	2.5	60	1.295	79.11
7	3	65	1.295	89.54
8	4	76	1.295	95.83
9	5	87	1.226	105.706
10	7.5	100	1.226	128.245
11	10	111	1.226	140.059
12	12.5	120	1.226	152.12

CBR value corresponding to 2.5 mm penetration = (79.11/1370)*100 = 5.77 %

CBR value corresponding to 5mm penetration = (105.706/2055)*100 = 5.14 %

CBR value of the soil = 5.77 %



SODIUM BENTONITE + 10% SCBA

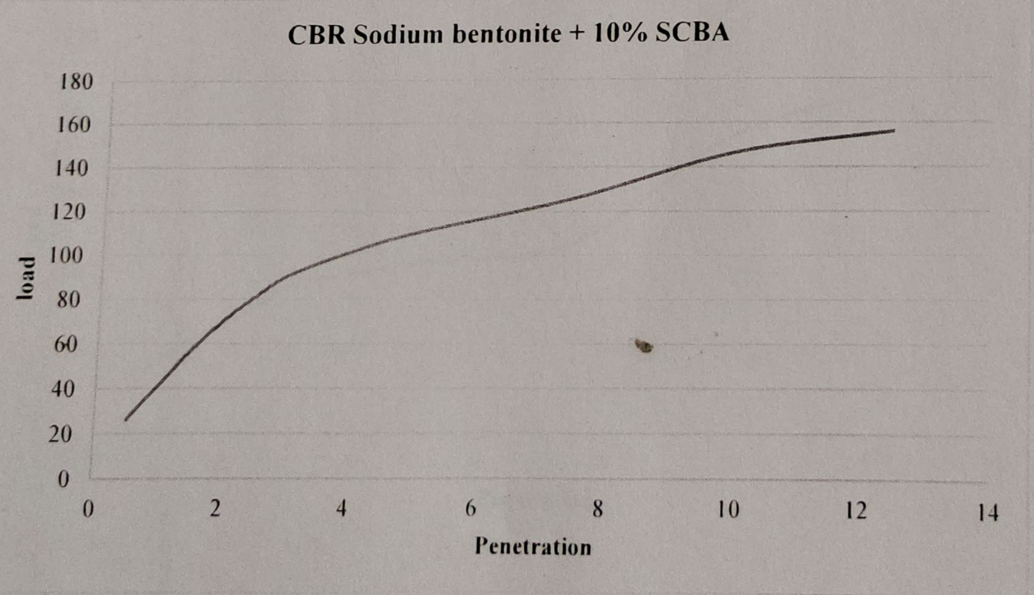
Table 49. CBR Sodium bentonite + 10% SCBA

S No.	Penetration (mm)	Proof ring reading (div)	Calibration factor	Load (kg)
1	0	0	-	-
2	0.5	21	1.295	26.2
3	1	34	1.295	42.25
4	1.5	4	1.295	57.95
5	2.0	54	1.295	70.84
6	2.5	60	1.295	81.51
7	3	65	1.295	90.74
8	4	76	1.295	101.63
9	5	87	1.226	110.106
10	7.5	100	1.226	125.845
11	10	111	1.226	146.459
12	12.5	120	1.226	156.122

CBR value corresponding to 2.5 mm penetration = (81.51/1370)*100 = 5.94 %

CBR value corresponding to 5mm penetration = (110.106/2055)*100 = 5.35 %

CBR value of the soil = 5.94 %

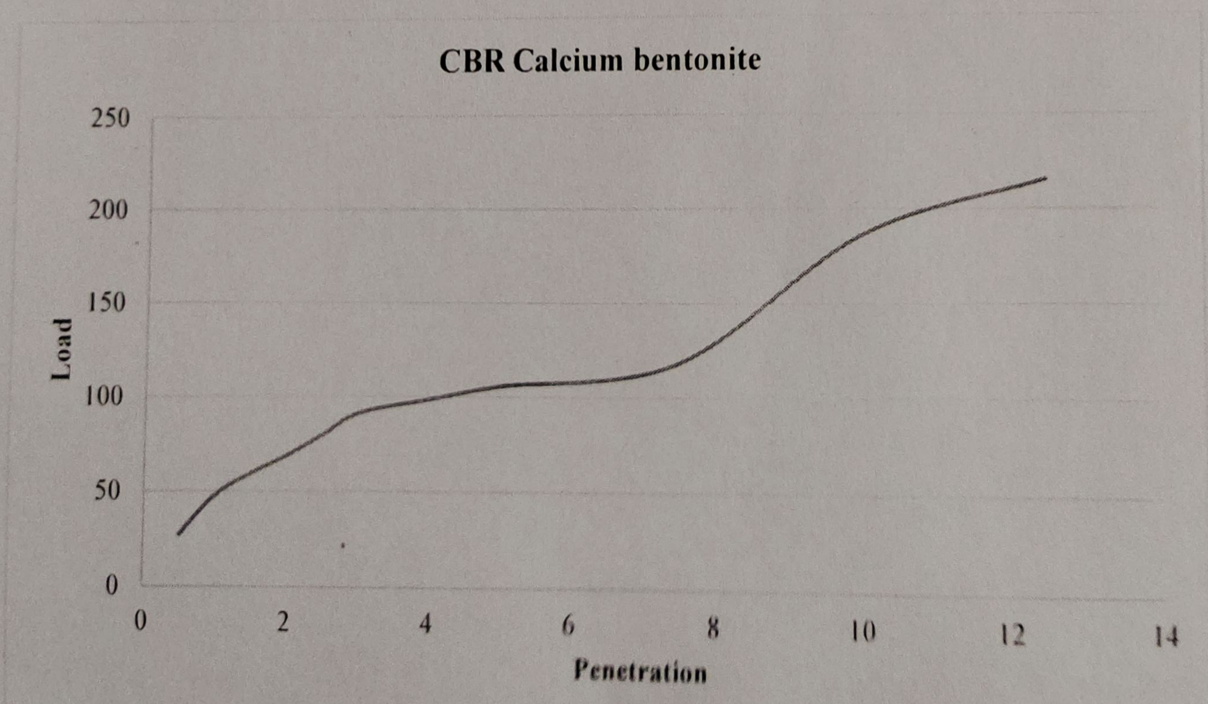


CALCIUM BENTONITE

Table 50. CBR Calcium bentonite

S No.	Penetration (mm)	Proof ring reading (div)	Calibration factor	Load (kg)
1	0	0	-	-
2	0.5	21	1.295	27.195
3	1	31	1.295	48.145
4	1.5	36	1.295	59.620
5	2.0	40	1.295	68.800
6	2.5	43	1.295	79.685
7	3	48	1.295	89.160
8	4	53	1.295	98.635
9	5	57	1.226	105.815
10	7.5	81	1.226	118.306
11	10	152	1.226	186.352
12	12.5	174	1.226	215.760

- CBR value corresponding to 2.5mm penetration = $\frac{79.685}{1370} \times 100 = 5.8\%$
- CBR value corresponding to 5mm penetration= $\frac{105.815}{2055} \times 100 = 5.1\%$
- CBR value of the soil = **5.8%**

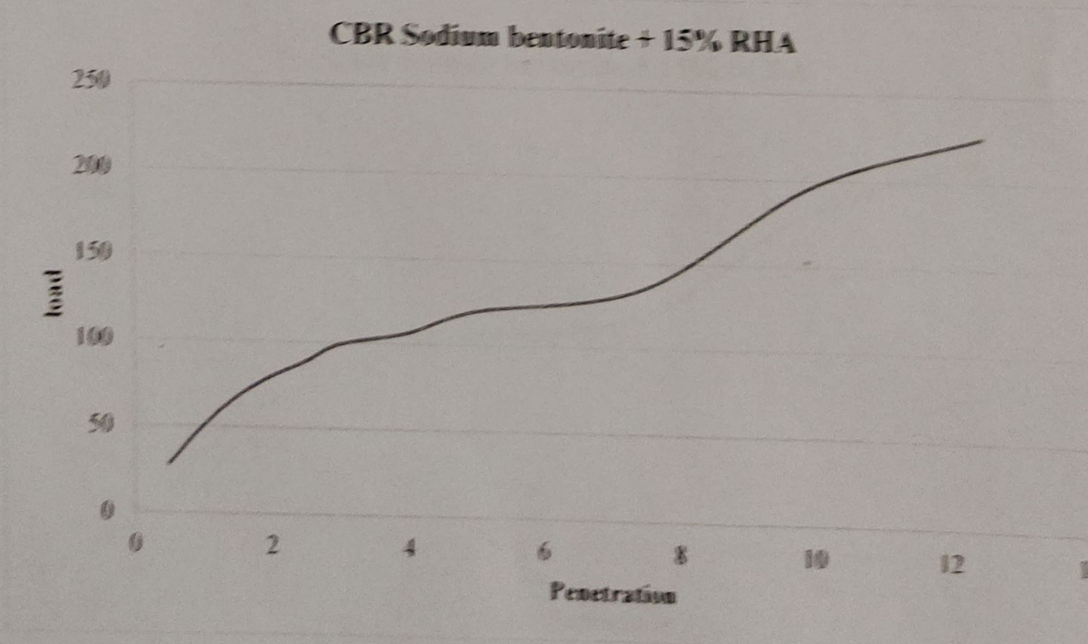


CALCIUM BENTONITE + 15 % RHA

Table 51. CBR Sodium bentonite + 15% RHA

S No.	Penetration (mm)	Proof ring reading (div)	Calibration factor	Load (kg)
1	0	0	-	-
2	0.5	21	1.295	28.195
3	1	31	1.295	50.254
4	1.5	36	1.295	67.620
5	2.0	40	1.295	79.800
6	2.5	43	1.295	88.685
7	3	48	1.295	99.160
8	4	53	1.295	106.635
9	5	57	1.226	119.815
10	7.5	81	1.226	135.306
11	10	152	1.226	196.352
12	12.5	174	1.226	225.760

- CBR value corresponding to 2.5mm penetration = $\frac{88.685}{1370}$ x 100 = 6.47%
- CBR value corresponding to 5mm penetration= $\frac{119.815}{2055}$ x 100 = 5.8%
- CBR value of the soil = **6.47%**

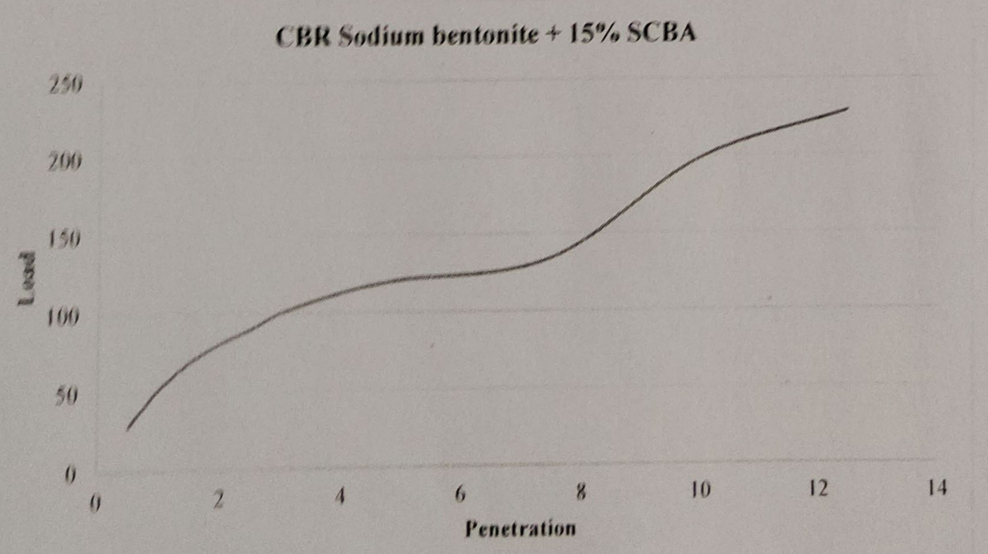


CALCIUM BENTONITE + 15% SCBA

Table 52. CBR Sodium bentonite + 15% SCBA

S No.	Penetration (mm)	Proof ring reading (div)	Calibration factor	Load (kg)
1	0	0	-	-
2	0.5	21	1.295	28.195
3	1	31	1.295	51.554
4	1.5	36	1.295	68.920
5	2.0	40	1.295	80.780
6	2.5	43	1.295	89.785
7	3	48	1.295	100.160
8	4	53	1.295	112.935
9	5	57	1.226	120.948
10	7.5	81	1.226	134.386
11	10	152	1.226	198.352
12	12.5	174	1.226	228.660

- CBR value corresponding to 2.5mm penetration = $\frac{61.160}{1370} \times 100 = 6.5\%$
- CBR value corresponding to 5mm penetration= $\frac{120.948}{2055} \times 100 = 5.8\%$
- CBR value of the soil = **6.5%**



Discussion

It is visisble from the results thst on mixing RHA and SCBA with calcium bentonite and sodium bentonite, the physical properties of bentonite clay has shown significant change.

- Calcium bentonite with SCBA 4.06 % to 4.46%
- Calcium bentonite with RHA 4.06% to 4.35%
- Sodium bentonite with RHA 5.48% to 5.77%
- Sodium bentonite with SCBA 5.48 to 5.94

CHAPTER-7

CONCLUSION

After the completion of this project, following results have been observed:

1.Swelling of Bentonite soil is observed to decrease significantly

2. Positive impact on strength of soil.

3. Better stabilization of bentonite soil

4. Resolving the problem of agricultural waste

5. Sustainable approach in decreasing waste.

CHAPTER – 8

REFRENCE

- IS: 2720(part V)-1985 "Determination of liquid limit and plastic limit" Bureau of Indian Standard , New Delhi .
- IS : 2720(Part XL)-1977 "Determination of free sell index " Bureau of Indain Standard , New Delhi
- IS : 2720(Part III)-1980 "Determination of specific gravity soil" Bureau of Indain Standard , New Delhi
- IS: 2720(partVII)-1980 "Light compacton test of soil" Bureau of Indain Standard , New Delhi
- IS : 2720(PartX)-1995 "Unconfined Compressive Strength Test" , Bureau of Indain Standard , New Delhi
- IS : 2720(Part.XVI)-1997 "California Bearing RatioTest" , Bureau of Indain Standard , New Delhi

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