“IMPROVEMENT OF SHEAR STRENGTH AND DURABILITY USING A MIX OF RHA AND CEMENT”

A PROJECT

Submitted in partial fulfillment of the requirements for the award of the degree of

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Under the supervision of
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to

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CERTIFICATE

This is to certify that the work which is being presented in the project title **"IMPROVEMENT OF SHEAR STRENGTH AND DURABILITY USING A MIX OF RHA AND CEMENT"** in partial fulfilment of the requirements for the award of the degree of Bachelor of technology and submitted to Civil Engineering Department, Jaypee University of Information Technology, Waknaghat is an authentic record of work carried out by **Pankaj Bansal (121679),Lucky Garg (121680)** during a period from February 2016 to June 2016 under the supervision of **Prof. Dr. Ashok Kumar Gupta** Professor & Head of Department, Civil Engineering Department, Jaypee University of Information Technology, Waknaghat.

The above statement made is correct to the best of my knowledge.

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ABSTRACT

Soil improvement is gaining popularity among the Construction engineering works because of the low land surface to population amount in our country. The present study experiment work performed by using the easy or suitable locally available material Rice Husk Ash as a stabilized of soil along with cement. Rice Husk Ash produced is huge Quantity by rice mill industry generally must be disposed off safely in order to have a effect minimum on the environment surface. Generally RHA used for geotechnical works may proved to a economical or suitable method for the pollution free disposal of Rice Husk Ash.

In this thesis work clayey soil used was obtained from Badal Pind near Bathinda and Rice Husk Ash used was brought from KGR Argo Private Limited, Hambran Road, Ludhiana. In this present study the effect of Cement and RHA on the clayey soil. To observed this performance Compaction test, California Bearing ratio test, Permeability test and durability test on soil samples. Compaction test may be results by amount adding RHA the MDD decrease and OWC Increases. Tests are performed on different mix proportions of RHA and Cement amount at their with OWC. Soil was mixed with 0%, 6%, 12% & 18% of RHA along with 0%, 3%, 5% & & 7% Cement. The different parameter were understand which showing significant improvement in strength of stabilizing soil. The maximum CBR value is at 7% cement and 12% RHA. Further RHA amount is increased CBR value decreases. Coefficient of permeability (k) may be test study decrease with increase RHA amount and Permeability (k) values increased with Cement contents. Durability test are also examined with RHA and Cement mix proportion after 7 and 14 days curing period. It showing significant resistance to wetting and drying cycles of durability.

LIST OF TABLE

NOMENCLATURE

AASTHO - American Association of State Highway and Transportation Official

ASTM - American Society for Testing and Materials

CI - Clay of intermediate plasticity

CBR - California Bearing Ratio

cm – Centimeter

gm - Gram

IS - Indian standard

kg - Kilogram

kN - Kilo Newton

MDD - Maximum Dry Density

mm – Millimeter

OWC – Optimum Water Content

OPC - Ordinary Portland Cement

RH - Rice Husk

RHA - Rice Husk Ash

Wt. - Weight

H_2O - Water

LIST OF FIGURES

CONTENTS

CHAPTER - 1

INTRODUCTION

1.1 GENERAL

Soil is basically natural construction material. It transmits the Load over come due to Construction above the ground surface and In case of Roads or highways the soil sub-grade supported the sub base course, base course and surface course of Pavement. The existing soil at a particular position may not economical or suitable for Development because of soil very low bearing capacity and higher compressibility or sometimes more high swell in case of clay. There is more need to concentrate on improvement soil properties by using of agricultural waste material like rice husk ash etc. which are mainly having cementious properties to decrease the cost of soil improvement.

Clay is most generally undesirable engineering properties of soil because of more swelling and more shrinkage. The clay particles sizes are small and water retention capacity more that means clayey soil is a weak soil. The supporting power (bearing capacity) of the clay is very low. The clayey soil generally weak soil that means permeability and compressibility low.The engineering properties of natural soil is very poor and create many problem for construction work. Clayey soil can be improvement by different using method like Mechanical stabilization, Chemical stabilization, thermal stabilization etc .the large number of binding agents materials like Lime ,Cement, fly ash, Rice husk ash etc are used in chemical stabilization. In this present experimental study to improve the engineering properties of clayey soil by using rice husk ash.

1.2 SOIL STABILIZATION

Stabilization is method performed on soil many year ago with main motive to make soil capable of attaining the require of civil engineering projects. Several additives which may be helpful for ground surface modification like as cement, lime & mineral additives like as rice husk ash, fly ash, gypsum etc have been uses. In this modern age Development of a country such as India posses abundantly available agro based on some resources and product collected from industries. Many of which are using along with variety of low cost value material. Other hand developed countries have accept and following the concepts of no products waste. All products are known as new resources by burning fuel in kilns while manufacture other effect able goods. the soil properties may altered in many method which as follows:

1. Mechanical method, compaction etc.
2. Admixture method using cement, lime.
3. Thermal treatment method.
4. Sand blanket method.
5. Geo-textiles.
6. Surface reinforcement.
7. Grouting the soil sub grade.
8. Stabilization by grouting.
9. Electro-osmosis.
10. Consolidation method.
11. Drainage method.

1.3 APPLICATION OF SOIL STABILIZATION

Stabilization is helpful for the following cases:

1. Earthen embankment by store water.
2. Foundation of heavy structures like dams.
3. Retaining walls.
4. Road construction.
5. Machine foundation.
6. Highways speed is smooth.

1.4 INTRODUCTION OF RICE HUSK AND RICE HUSK ASH

The production of rice husk has increased day by day in all over the world. It is accounted that 300 kg of rice husk is producefrom every ton of rice. Rice husk is obtained from rice mill which is known as husk. It is information that during mill of paddy approximately about 22% by weight of rice husk and remaining 78% by weight is received as rice. Rice production in the world is estimated that about 500 million tons. Asian countries farmers generally produce rice 85% of total generate with in to countries. Every 1000kg of paddy milled about 220kgs (22%)of rice husk is generated. the rice husk burning that is called rice husk ash which useful to environmental pollution. So it merit to reproduce the waste material to manufacture useful commodities.

As per data given by (Hwang and Chandra,2009) India generally one of most rice producing country in the worldwide. The rice of production is given in the table below:

Table 1.1: Rate of Production of Rice Paddy and Rice Husk in the world (in Million Metric tons), (Hwang & Chandra,2009)

COUNTRY	RICE PADDY (Million metric ton)	RICE HUSK (Million metric ton)
Bangladesh	25	5.5
Brazil	10	2.0
Burma	12	3.0
China	184	42
India	116	24
Indonesia	40	10
Japan	14	2.6
Korea	12	2
Philippines	10	1.2
Taiwan	16	2.2
Thailand	22	3
Us	6	1.2
Vietnam	16	2.8
Others	17	4.5
Total	500	106

1.5 NATURE OF RICE HUSK ASH PRODUCED

Rice husk removal from paddy is done in husker type of hulling machine. In this work a huge amount of rice husk is taken in un broken form in husker wih the huge part as form of dirt contamination with burn and very fine particles of rice. Rice hull is the outer shell of the rice paddy grains and constitutes nearly 22% of paddy by weight. During the working process of partition of external husker from paddy grains the external husker is isolated from grains and obtained as rice husk that means waste material from paddy grains. Rice husk is generally made up of two parts:

1. Organic mineral

2. Inorganic mineral

1. Organic mineral - which is roughly 75-85% by weight of dry rice husk that is called organic mineral.

2. Inorganic mineral -which is roughly 25-35% by weight of dry rice husk that is called inorganic mineral.

1.6 PROPERTIES OF RICE HUSK ASH

End using of waste material depend upon it physical properties and chemical properties. Chemical properties of rice husk generally depend upon sample to sample because due to changes in weather forecast conditions.. As per, KGR Agro Limited. RHA contains amorphous silica is 87%. the composition of RHA in the table given below:

Table 1.2: Chemical Properties of Rice Husk Ash

(KGR Agro Private Limited, Ludhiana (Punjab)

S No.	Component	Percentage (%)
1.	Silicon dioxide (SiO_2)	87
2.	Aluminium oxide (AI_2O_3)	2.50
3.	Iron oxide (FeO)	0.65
4.	Carbon (C)	6.50
5.	Calcium Oxide (CaO)	2.10
6.	Magnesium oxide (MgO)	0.80
7.	Titanium dioxide (TiO_2)	0.04
8.	Other oxides	0.41

1.7 COMPONENTS OF RICE AND ITS STRUCTURE

It is generally rice husk, silica amount is very high. organic matter amount of silica is correctly bonded. the silica portion in rice husk ash is un-dissolvedin alkali and temperature is high.it has pass that organic part of rice hull is extracted the inorganic may be relatively pure& forming a fine silica of source.

1.8 DECOMPOSITION OF RICE HUSK AT DIFFERENT TEMPRATURE

There are two different process of stages for the decomposition of rice hull which are as following:

1. Carbonization Process.

2. Decarbonation Process.

1. Carbonization: Carbonization is process which is defined as decay of volatile matter present in rice hull at high temperature. It is generally more than 320*C by which some gases and tar are removed.

2. Decarbonation: Decarbonation is process defined as the carbon present in rice hull up to certain extent at very high temperature in the present oxygen. RHA melting temperature is 1450*C.

1.9 POZZOLONCITY OF RICR HUSK ASH

Pozzolanic reaction is Recognized with strength of silica to bonded with calcium hydroxide to silicates hydrates. the agree work to find out Pozzolanicity is to measure the percentage of calcium hydroxide present in liquid phase in contact with material tested., with the percentage of calcium hydroxide necessary to saturate a solve with same alkalinity. the test of results are shown as m moles/liter of CaO vs m moles/liter of OH are balance with solubility curve at 39*C of calcium hydroxide related to alkalinity of the solve. if he number of values alkalinity down under solubility curve the mixture is Pozzolonic considered.

1.10 DISPOSAL OF RICE HUSK ASH

In developed countries like China and India which generate large amount of rice, disposal of rice husk ash is huge problem. As 500 million tons of RH is produced comprehensively which has an huge impact on environment s if RHA is not properly disposed. One simple and effective method used these days is rice husk is used as fuel in ovens. This type of oven helps to produce different clays products which are used in daily routine life. During the method of burning husk in kilns 20%of the remainingproduct is in the form of ash whose disposal is a huge issue. In present an effective effort has been made to userice husk ash for geotechnical works after mixing soil and cement.

1.11 USE OF RICE HUSK

Producing of rice countries like china and India are regularly find out researching which depend up on rice husk generally using for industrial works or purposes. some of Present and potential and application various site are given below:

1. Non energy generation application.

2. Energy generation application.

1. Non energy application:

a). Building material with fine thermal insulation.

b). Controlling of pest agent.

2. Energy generation application

a) Gasification

b) Combustion

c) Pyrolysis.

1.12 TEMPRATURE EFFECT DURING BURNING OF RICE HUSK

Burning of rice hull ,ash is containing higher percentage of silica in crystalline form. however, if rice husk is burn under controlled situation more reactive amorphous silica is produced. it is generally noticed that the ash formed at lower temperature (772-872K) contains of amorphous silica. Silica is one of the industrial minerals along with china clay,(tale or calcium carbonate), which is generally using in rubber, paint works etc. amorphous silica having a lot of more purity, particle pieces small and surface area can be using as an catalyst carries in good chemical synthesis. In prepare to order silica with higher purity from of rice husk, either thermal method of the rice husk or method with different chemical was filled before and after combustion at temperature from 772 to 1670K for different interval of time.

If rice husk ash may be using profitably through value addition, there will be simple and economical benefits to the process and to the national economy. value addition of product including wastes is depend up on clear understood of its structure and composition. chemical properties is one such property, which study the end use of any materialor product.

1.13 OBJECTIVE OF STUDY

The objectives of the study are:

1. To understand the variation in engineering properties of clayey soil by adding different proportions of cement (at 0%, 3%, 5% & 7%) and RHA (at 0%, 6%, 12% & 18%) of the weight dry soil.

2. To study the effect of cement (at 0%, 3%, 5% & 7%) and RHA (at 0%, 6%, 12% & 18%) on California Bearing Ratio values of clayey soil.

3. To determine the effect of cement (at 0%, 3%, 5% & 7%) and RHA (at 0%, 6%, 12% & 18%) on Permeability test.

CHAPTER 2

LITERATURE REVIEW

In This Chapter Literature Review for available Rice Husk Ash is mostly used for different purposes mixed in various proportion for experiment investigation. At present, Geotechnical engineering projects planning, construction and design are generally depend upon test results followed from AASTHO AND ASTM (American Society For Testing Materials) Standards. Field work conditions are significant various, many progressive failure may be occur. To study soil behaviors under in situ conditions, it necessary to observe behavior of soil as closely to actual conditions as possible. So to understand Rice Husk Ash that has been used in the present study, RHA is obtained from KGR Argo private limited, Ludhiana. To arrive at logical results RHA effect on soil properties has got to be Examined or defined before recommendations can be made for it application as a construction, supporting and surrounding material for the structures. Normally using of agriculture waste like as RHA for improvement of soil is a cost effective or suitable method. it will also help to solve problems of disposing of industrial or agriculture waste product. The work done by various analysis from time to time use RHA with various sorts of soil is listed below:

- **Jha, J. N and Gill, K. S (2006)**Performed experiments work like CBR test, Compaction test &durability test on clay-RHA-lime mix proportions. Unconfined strength of mixes is studied after 7, 28, 56 days curing period and observed that by lime content 7% and at 28 days curing period is noticed that maximum strengthof RHA sample is 1.77 times.RHA and Soil sample with mixing limecontent 5% or RHA 6% content showing increase in strength by 1.37 times than that the soil sample with mixing 7% lime or without RHA after 56 days curing period.The soil mix gain of strength in lime is primarily due to Pozzolanic reaction between alumina or silica from lime and soil, by various amount adding Rice husk ash to clay soil silica of amount are available for reacted with lime resulting in further strength is improved. They also studied that the occurrence of RHA in lime soil mix past supreme quality does not improve strength.Growth of RHA, CBR test shows likewise increment because of Pozzolanic reaction in lime material i.e. 3%, 5% and 7%. Optimum doseof RHA is 12% which is affirmed by understandingmore change in CBR values. Compaction test for 12% RHA sample gives great solidness subsequent to directing 12 cycles of drying or wetting process on 28 days curing.

- **Brooks, Robert, M. (2009)** In this report has generally Analyse on soil stabilization by using RHA and FA(rice husk ash and fly ash) on expansive soil. Remoulded soil or price correlation was made for settled of sub base course of highway works with joining or not inclusion of admixture soil stabilization. the tests generally performed showing that the stress and strain curves when fly ash percentage is increased from 0% to 25% and RHA content 0% to 12%. So that RHA amount 12% and fly ash amount 25% was Optimum for strengthening of expansive soil.
- **Setyo Muntohar et al. (2013)**In this report study on soil stabilization by using lime and RHA on Silty soil. This paper noticed that the plastic fibre is using reinforcing the Silty soil. the bonded mixture of RHA or Lime enhance the compressive and tensile strength of the soil up to 4 -5 times of the initial value. Inclusion of plastic waste fibre in the soil

plays a important role on the increment of tensile or compressive strength of the soil. the curing period is mostly effect on strength of the specimen and more strength increased. the Supreme value of plastic fibre amount in the mixture is 0.4% on further increasing the quantity of plastic fibre the value of cohesion decreased.

- **Mohammed, Y Fattah et al. (2013)**In thispaper various tests performed on clayey soil by various mix proportions of Rice Husk Ash. the test are generally performed on clayey soil such asIndex properties, Unconfined compression test and consolidation test. it was examine that the liquid limit of these soil is reduced, while soil of P. I. is decreased about 30 - 60%. the OWC is expanded with the increment of RHA materials. the percentage of RHA is maximum at RHA b/w 6 - 8%.
- **Roy, Aparna (2014)** This report observed on soil stabilization by using cement & RHA on clayey soil. Cement amount is small added at different %age of RHA. the test are performed to find out various properties of soil such as Maximum dry density, Optimum water content, California bearing ratio test or Unconfined Strength test. the result present that increasing the content of RHA the MDD also decreases. So the decrease in MDD is using different percentage of RHA in mixture and increase in the quantity of RHA the Optimum water content increased because various %age of RHA adding in clayey soil that means decreased the silt free with surface zone bigger is formed. these process need more water to take place. In CBR test value is increased by 106% with the amount of 10% RHA. CBR value mostly decreased with RHA content is increased to15%.Unconfined compressive stres value is increased by 90.2% with

amountof 10% RHA and further the value is mainly decreased with RHA amount is increased to 15%.

- **Sabat, Kumar, Akshaya (2014)** Conducted the shear strength parameters, CBR test and durability of an expansive soil by using RHA and Lime sludge. In this paper has been explained the effect of its 7 days or 28 days curing period on these soil properties except the compaction properties. when the rice husk ash content added the CBR value is increased up to 10% after added RHAmore % age the value of CBR test start decreasing that means RHA optimum value is 10%. On added of RHA 10% the value of CBR test is increased from 1.90% to 2.80%. With addition of various %age of lime sludge the CBR value of RHA stabilized soil increased up to 18%. the curing period effect on improvement in CBR values. Sample of soil of curing period of 28 days strength more as compared 7 days curing. the UCS value also increasing up to 10% of RHA content. The value of UCS generally increased 68 kN/m^3 from 59 kN/m^3 when RHA is 10%.
- **Shinghai, Kumar, Anil.et al. (2014)**In this report has examine on soil stabilization by using natural material like RHA and Fly ash on expansive soil. RHA and fly ash materials using in soil is improved physical Features. Various test performed like shear strength, P. I., CBR test & UCS test. Black cotton soil generally used as an expansive soil. This paper shows that Black cotton soil is mixing by various mix proportion of RHA and fly ash. the soil is mixing with RHA content 10% to 30% and fly ash content 5% to 25%at the 28 days curing period. Liquid limit of the soil reducesto 50% by using fly ash is 20% and RHA is 25%. P. I. of the soil is reduced to 80% to 90% with mixing

of 25% RHA and 20% fly ash in soil sample. free swell is reduced 65% to 70%with mixing 15% fly ash and RHA 20%. Specific gravity is mostly reduced.

- .**Sabat, kumar, Akshaya et al. (2014)** Performed different test on soil stabilization of expansive soil by waste material like as Cement kiln dust, silica fume, Red and Brick dust etc. the soil stabilization using agriculture waste material such as Bagasse ash, Groundnut shell ash and Rice husk ash etc. the soil stabilization using domestic waste such as waste tyre, grain storage dust etc. Some waste materials using in soil stabilization of expansive soil it reduce cost and mostly improve its strength. In this paper also focused different method that how to using the waste materials in soil stabilization of expansive soils. The researchers had Analysis the effect of soil stabilization on different properties such as Atterberg test, CBR test values, UCS and Swelling properties of expansive soil.
- **Kishore, Garima,Pandey et al. (2015)** In this report has understand on soil stabilization by using Rice Husk Ash and lime on sandy soil.The following tests were conducted like as Liquid Limit & Plastic Limit, Soaked CBR test , Un soaked CBR test and Permeability test. the results showing that Rice Husk ash content 10% to 25% and Lime content 3% to 9% Optimum water content increased and Maximum dry density decreased. UCS of soil is increased lime content 6% and RHA 10% or 15%. but decreased Rice Husk Ash content. UCS of soil is decreased. the optimum value 3% lime for UCS test.Unsoaked or Soaked CBR values is increases Lime content 6% with RHA 10% or 15% . but decreases value at 20% and 25%. Permeability values is increases Lime content 6% with RHA 10%, 15%. but decreases value at 20% and 25%.The Supreme value of permeability is at Lime 6% with RHA 15%.

CHAPTER 3

EXPERIMENTAL WORK

INTRODUCTION

Soil testing is an Basic portion of identify and design or construction in soil engineering work. A proper Judgement sample of soil and classify of it engineering characteristics of soil under the conditions is stable are key section in practice of Geotechnical engineering works. Soil is a generally natural or supporting material. it very important roles play in civil engineering projects such as water system designing or Irrigation work.

3.1 MATERIAL USED AND ITS TESTING PROCEDURE

To study the compaction and strength characteristics of soil by using cement and rice husk ash at various percentage and different tests are performed. the aim of the study is to observed the effects of different mix proportions of RHA(i.e. 0%, 6%, 12%, 18%) on clayey soil by addition of cement (i.e. 0%, 3%, 5%, 7%) on following parameter.

1. Optimum moisture content and maximum dry density of various mixes at various percentage.

2. California bearing ratio teat of various mixes at various percentage.

3. Permeability test of various mixes at various percentage.

3.1.1 SOIL SAMPLES

300 kg of soil sample was obtained from the site at Ludhiana and was air dried. It was hand sorted to eliminate any paper or vegetative matter. Then soil was dried for 24 hr. Soil was sieved through 4.75mm sieve to remove gravel fraction before mixing it with RHA and cement.

Table 3.1: Physical Properties of soil

S. NO.	Parameters	Results
1.	Light compaction test	
	a). MDD (gm/cc)	1.75
	b). OMC (%)	15
2.	Liquid limit (%)	40
3.	Plastic limit (%)	24
4.	Plasticity index (%)	16
5.	Specific gravity	2.61
6.	Indian soil classification	CI

Table 3.2: Grain size analysis of soil

Sieve Size (mm)	%age Passing	Test Method
4.75	100	
2.36	100	
1.18	100	
0.6	100	IS:2720 part - IV
0.3	100	
0.15	96.6	
0.075	92.9	

3.1.2 RICE HUSK ASH

The Rice husk ash used in the investigation is generally local RHA which was obtained from KGR Agro Private Limited, Ludhiana.

Table 3.3 Physical properties of RHA

S.NO.	Properties	Values
1.	Specific gravity	2.02
2.	Grain Size Analysis a). Gravel size fraction (%) b). Sand size fraction (%) c). silt & clay size fraction (%)	 0.00 55.2 44.8
3.	Optimum moisture content (%)	50.3
4.	Maximum Dry Density (kN/m^3)	9.10

Table 3.4: Chemical Properties of RHA

(KGR Agro Private Limited, Ludhiana (Punjab)

S No.	Component	Percentage (%)
1.	Silicon dioxide (SiO_2)	87
2.	Aluminium oxide (AI_2O_3)	2.50
3.	Iron oxide (FeO)	0.65
4.	Carbon (C)	6.50
5.	Calcium Oxide (CaO)	2.10
6.	Magnesium oxide (MgO)	0.80
7.	Titanium dioxide (TiO_2)	0.04
8.	Other oxides	0.41

Table3.5: Grain Analysis of RHA

Sieve Size (mm)	**%age Passing**	**Test Method**
4.75	100	
2.36	100	
0.6	100	IS:2720 part - IV
0.3	100	
0.075	55.2	

3.1.3 ORDIANRY PORTLAND CEMENT 43 GRADE

The Ordinary Portland Cement is obtained from Ultra tech cement company of grade 43 is used. Portland cement is one of the old material used for soil stabilization. Cement stabilization is various type of stabilization from other forms of Admixture stabilization. cement react with soil it solidifies the material of soil and strength of structural is basically obtained from cementing activity rather than from cohesion and waterproofing materials.

Table 3.6: Physical Properties of Cement used

Properties	Value Obtained
Grade	43
Initial setting time (min)	145
Final setting time (min)	190
Compressive strength (MPa)	
3 days strength	33
7 days strength	46
28 days strength	56

3.1.4 WATER

Ordinary Tap water was used throughout the study.

3.2 RICE HUSK ASH

The rice husk ash brought from mill was oven dried at 100 +5*C for 24 hours and sieved from 2.36mm sieve.

3.3 DIFFERENT MIX PROPORTIONS

Soil, Cement or RHA is to be mixing thoroughly to have uniform mixture by hand mixing using various mix proportion cement and RHA which are further separated into various samples of soil. The various mix proportion given below in the table:

Table 3.7:MIX PROPORTIONS OF SOIL + RHA+ CEMENT

Sample	Name of proportion	SOIL:RHA:CEMENT
Sample 1	Soil:RHA:Cement	100:0:0
Sample 2	Soil:RHA:Cement	95:0:5
Sample 3	Soil:RHA:Cement	89:6:5
Sample 4	Soil:RHA:Cement	83:12:5
Sample 5	Soil:RHA:Cement	77:18:5
Sample 6	Soil:RHA:Cement	93:0:7
Sample 7	Soil:RHA:Cement	87:6:7
Sample 8	Soil:RHA:Cement	81:12:7
Sample 9	Soil:RHA:Cement	75:18:7

3.4 DIFFERENT TESTS PERFORMED

- Atterberg' s Limit Test.
- Specific Gravity by Pycnometer.
- Standard Proctor Test for Determination of Maximum dry density and Optimum moisture content.
- Grain Size Analysis.
- California bearing Ratio test.
- Falling head Permeability test.

CALIFORNIA BEARING RATIO TEST (CBR TEST)

California bearing test as it generally developed by California division of highway in America. This test was adopted by U.S. crops of engineer for designing for base course for airfield pavement. C.B.Rstudy the road material qualities to be used soil base course materials. C.B.R test is generally simply load deformation performed in the soil laboratory or in-situ in the field. C.B.R test is used to identify the soil strength of sub grade for flexible pavements. C.B.R is also generally used for designing soil base course for airfield pavements. C. B. R test performed given below:

(i) California Bearing test may be studied on undisturbed soil in the laboratory. In-situ test are not applicable for design purposes. whenever possible by compaction of static method sample should be prepare otherwise by compaction of dynamic (light or heavy). this C.B. R test process should be strictly attached to.

(ii) Soil material should be compacted at it OMC to standard proctor dry density with help of rammer as adopting heavy compaction method is done. Sample of soil are compacted to maximum dry density which is expected to achieving in the field.

(iii) In Heavy compaction the soil is compacted in 5 equal layers filled at 56 No. of blows of 4.89 kg rammer on each layer.

(iv) In case of soaked C.B.R test the specimen in the mould is subjected to 4 days soaking before testing and water absorption values are note down.

Calculation of C. B. R. value.

C. B. R value are calculated from corresponding load penetration curve using the relation -

C. B. R value (%) = Load on soil sample / Standard load

The value at 2.5 mm Penetration = 1370kg

The values at 5.0 mm Penetration = 2055kg

The value at 7.5 mm Penetration = 2630kg

PERMEABILITY TEST

The test is used to determine the coefficient of permeability (k) of fine grained soil such as clay or silt etc. which are highly impervious in nature.The falling head permeability test is also called as falling or variable head Permeameter. In this test water pass through the sample of soil under falling head because sufficient water of quantity cannot be collected through the soil pores under constant head in a specified time.

(i) Measure the diameter of Permeamater and burette and also measure the length of soil sample.Fill the sample of soil in the Permeameter and place the porous discs or rubber stopper in position. the sample of soil is filled such way that no segregation take place.

(ii) Saturate the sample of soil by economical or suitable method.

(iii) Open the stop lock of the burette to remove any entrapped air inside the soil.

(iv) Close the stop lock and open the stop cock of the burette and allow the H_2O to pass through the sample of soil. Now start the watch at the same time and measure water level from h_1 and h_2 in time.

Calculation of Coefficient of permeability (K):

$K = 2.3* \ a. L / A. t* \ \log_{10} * h_1 / h_2$

L = Length of the soil sample (cm) and t = Average time interval (sec)

a = X - sectional area of stand (cm) and A = X - sectional area of soil sample (cm^2)

h_1 = initial head (cm) and h_2 = final head (cm^2)

CHAPTER 4

RESULTS AND DISCUSSION

INTRODUCTION

This chapter contains the results of different tests performed on soil in geotechnical lab at project site using different graphs and tables. The various tests for soil samples were performed at maximum dry density and optimum moisture content to determine the different parameter keeping soil: cement: RHA mixes proportion.

4.1 COMPACTION TEST

The compaction test of results are showing in the forms of graphs. A compaction curve plot between water content and dry density to obtained the Maximum Dry Density (MDD) and Optimum Water Content (OWC).

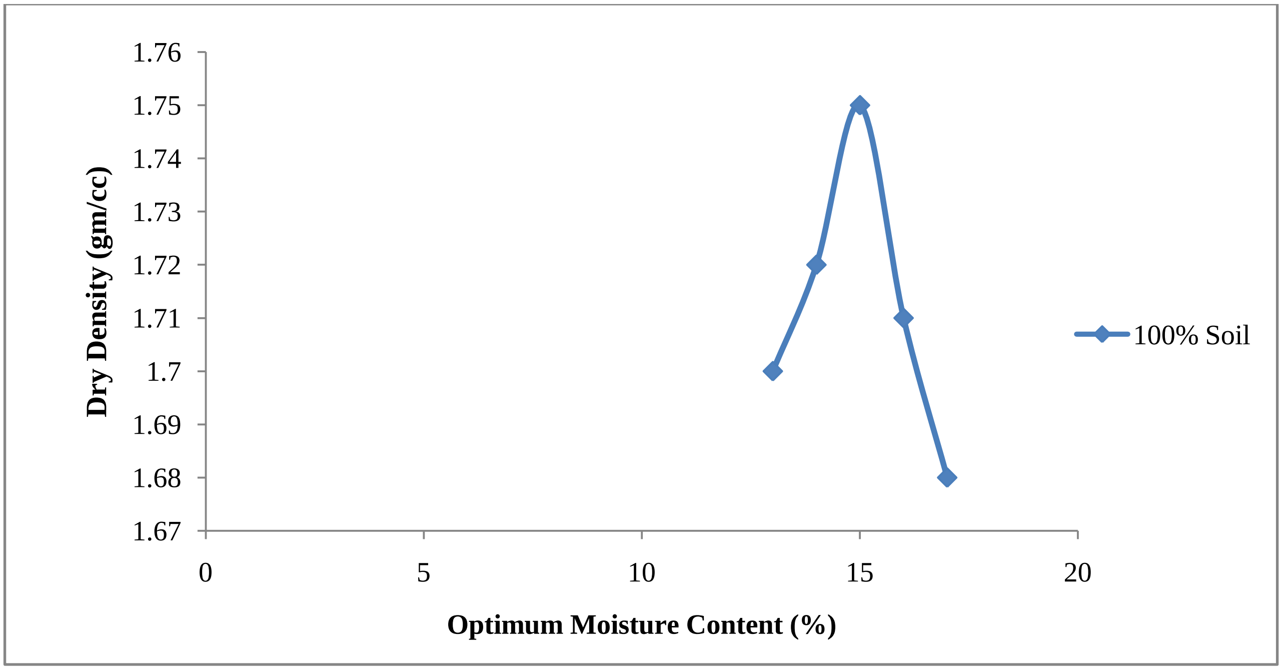

Figure 4.1: Graph showing Moisture - Density Relationship at Soil: RHA :Cement (100:0:0)

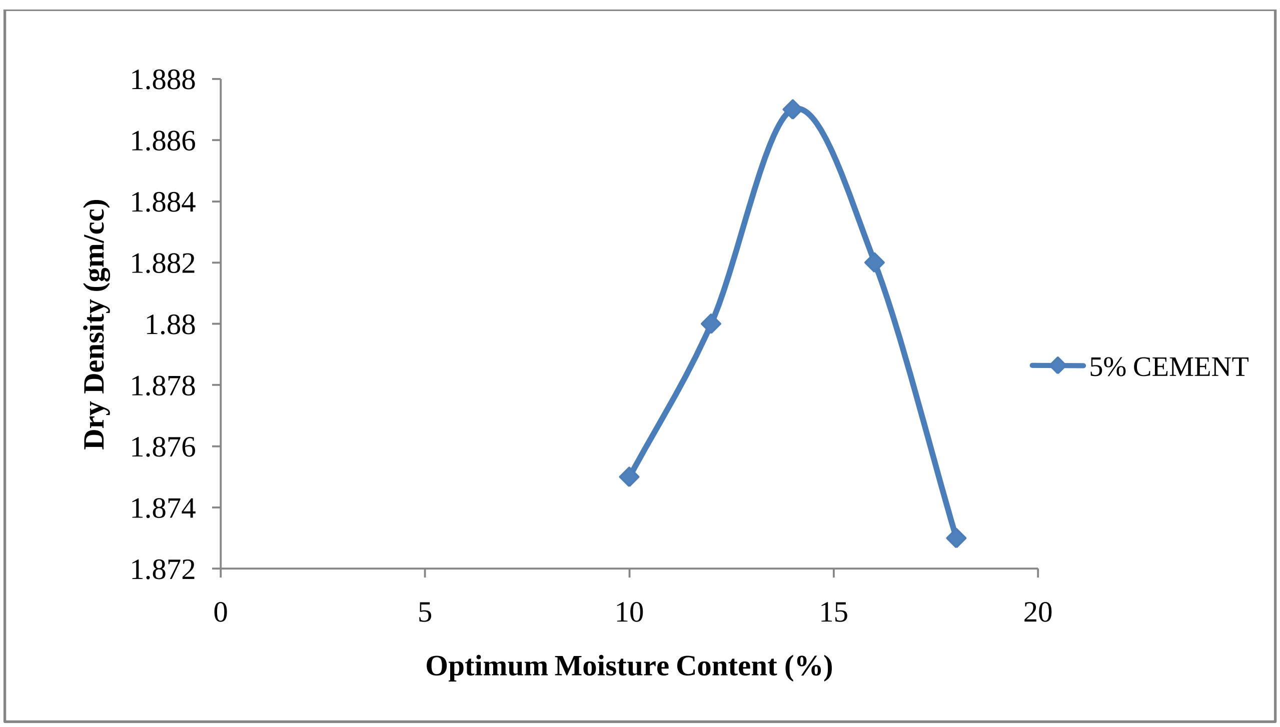

Figure 4.2: Graph showing Moisture-Density Relationship at Soil: RHA :Cement(95:0:5) mix

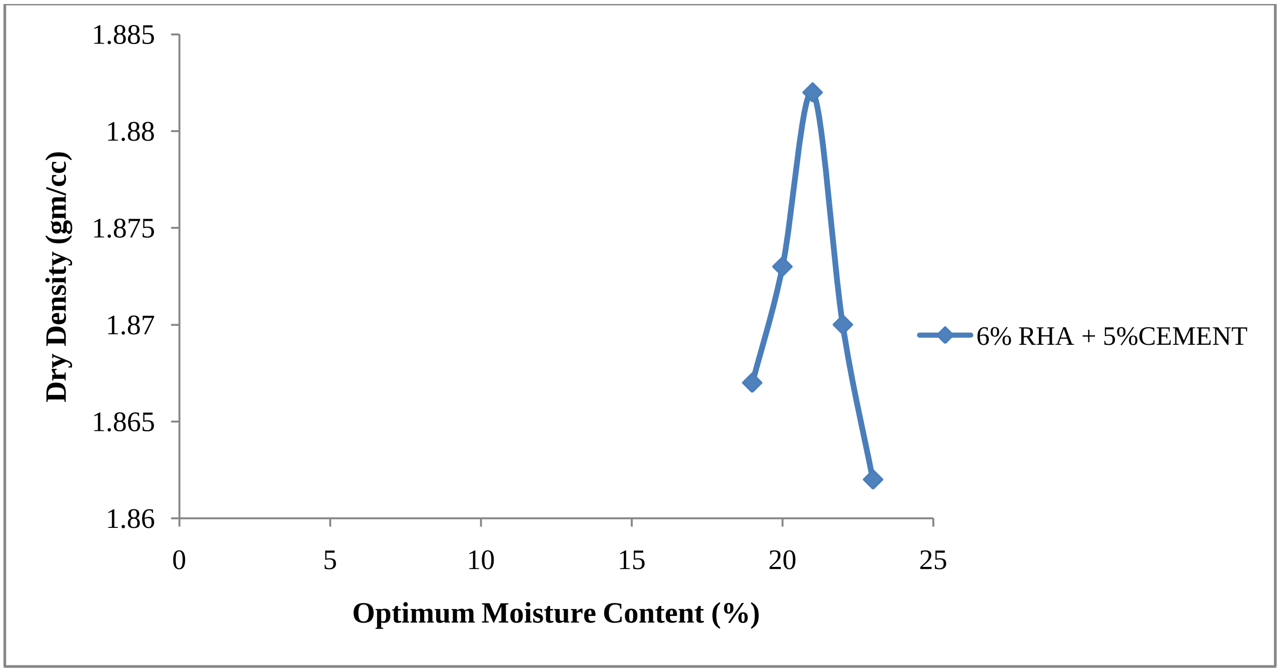

Figure 4.3: Graph showing Moisture-Density Relationship at Soil: RHA :Cement(89:6:5) mix

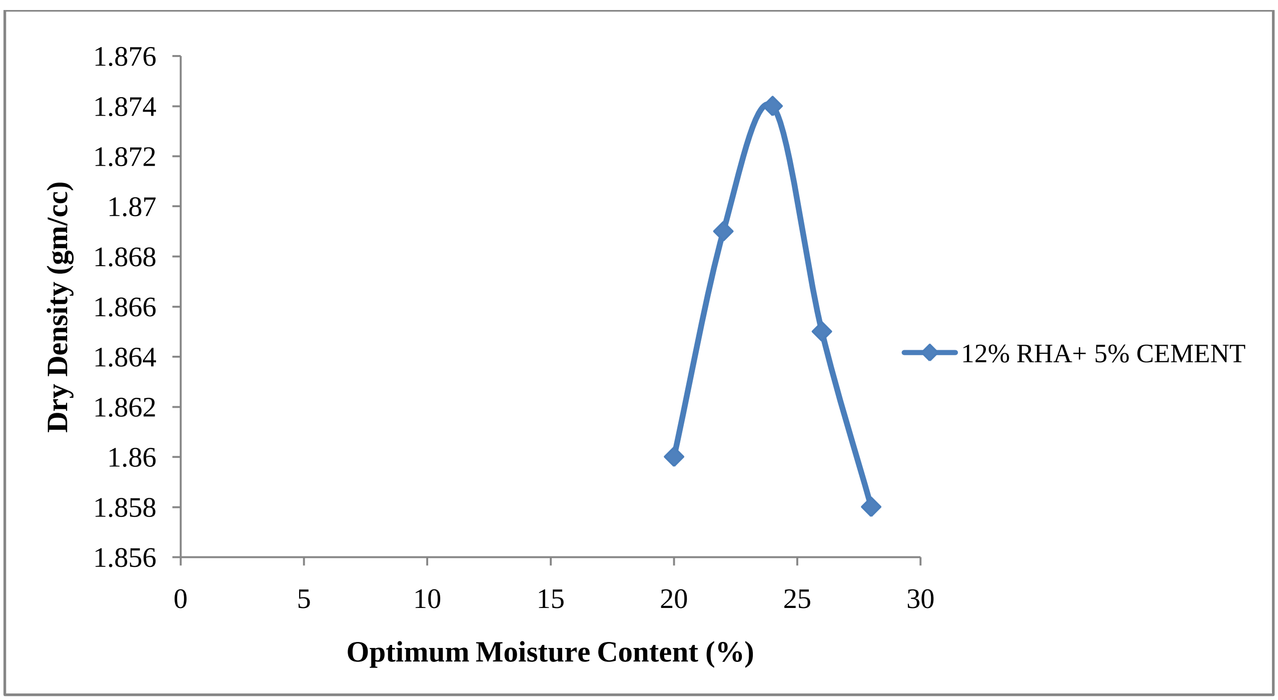

Figure 4.4: Graph showing Moisture-Density Relationship at Soil: RHA :Cement(83:12:5)

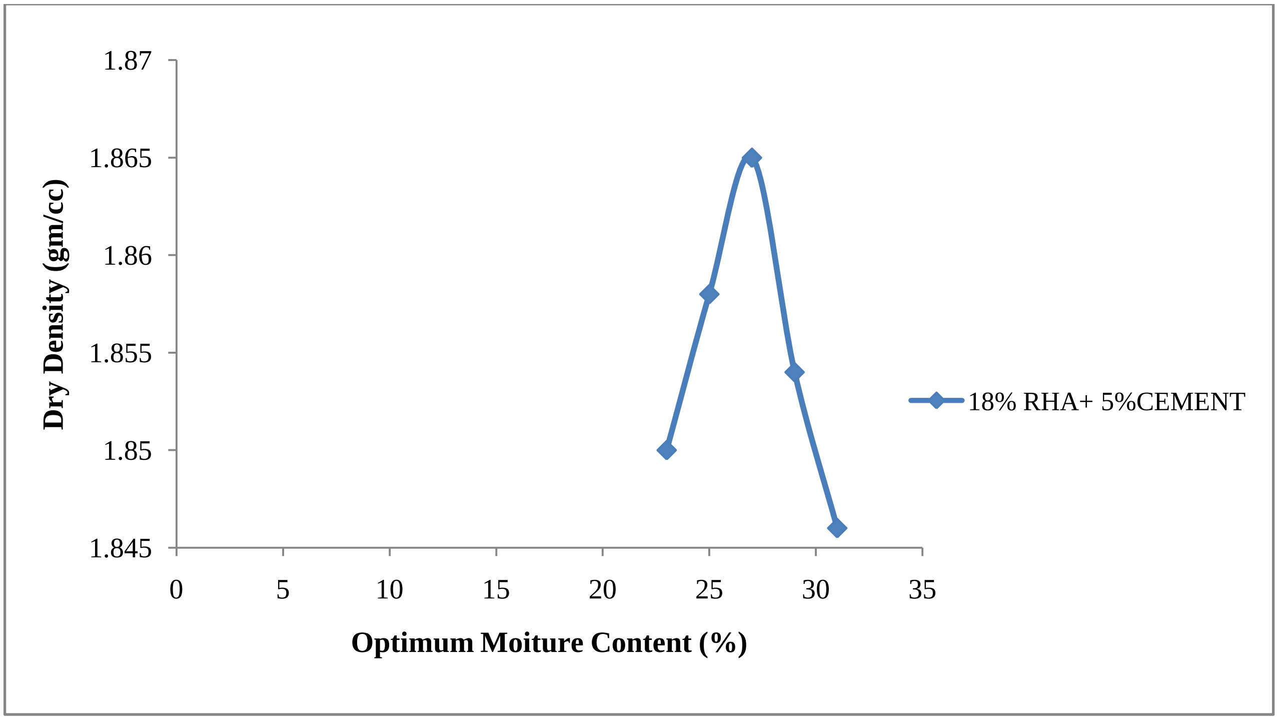

Figure 4.5: Graph showing Moisture-Density Relationship at Soil: RHA :Cement(77:18:5)

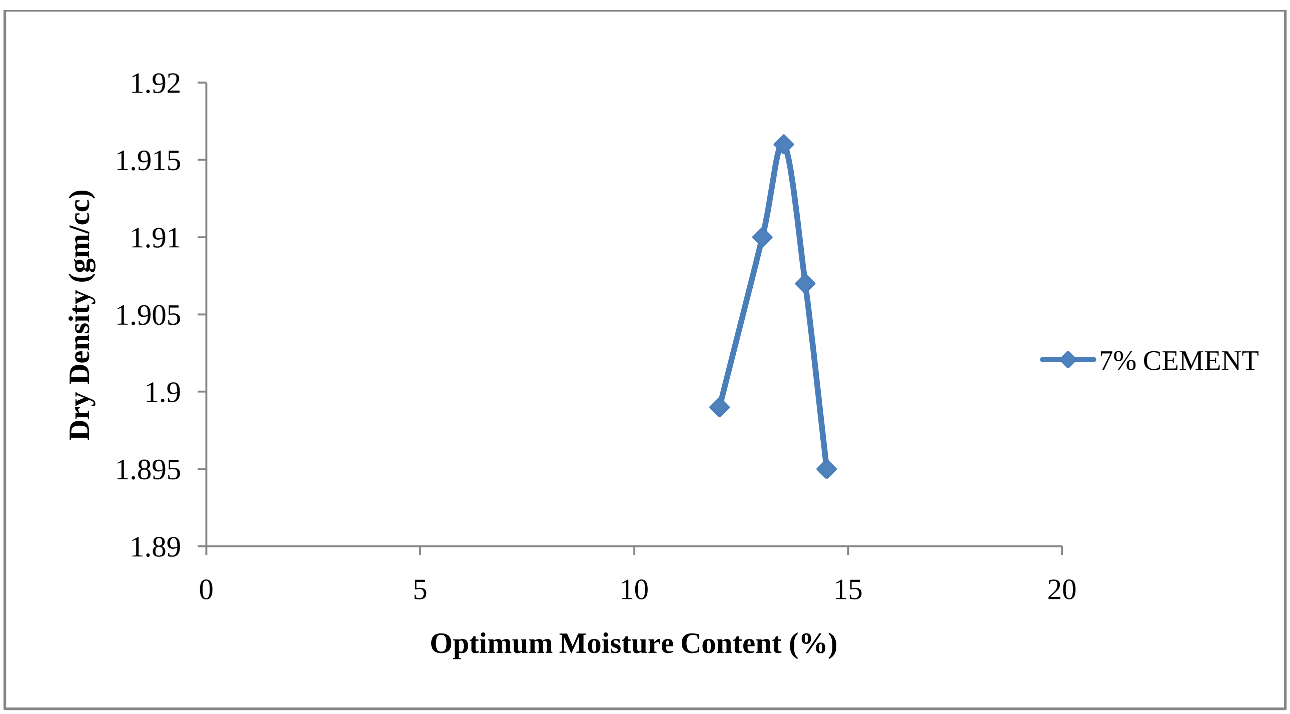

Figure 4.6: Graph showing Moisture-Density Relationship at Soil: RHA :Cement(93:0:7) mix

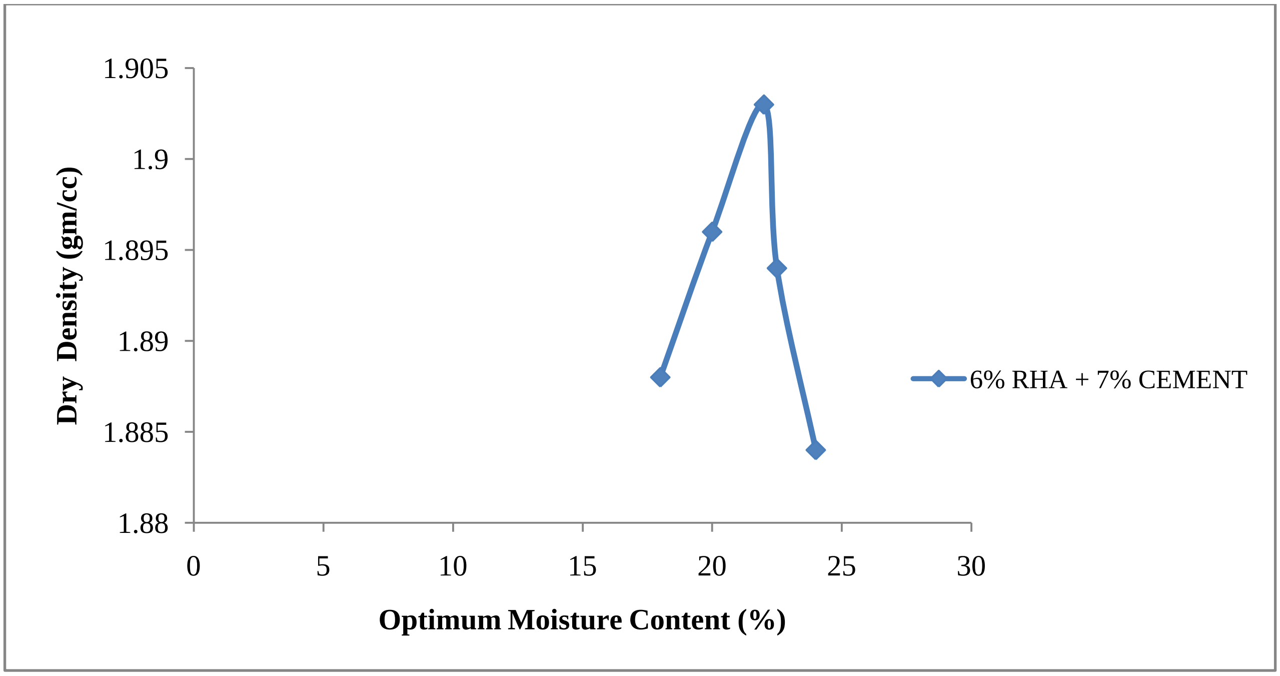

Figure 4.7: Graph showing Moisture-Density Relationship at Soil: RHA :Cement(87:6:7) mix

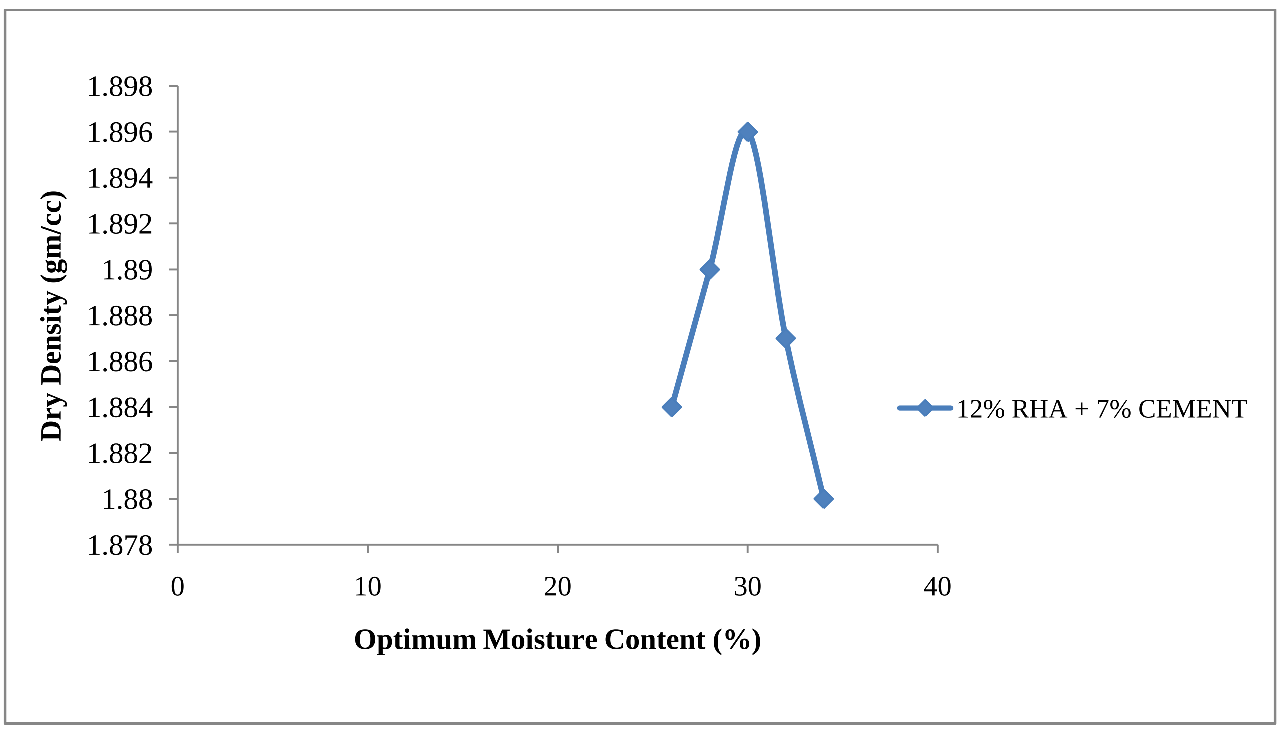

Figure 4.8: Graph showing Moisture-Density Relationship at Soil: RHA :Cement(81:12:7)

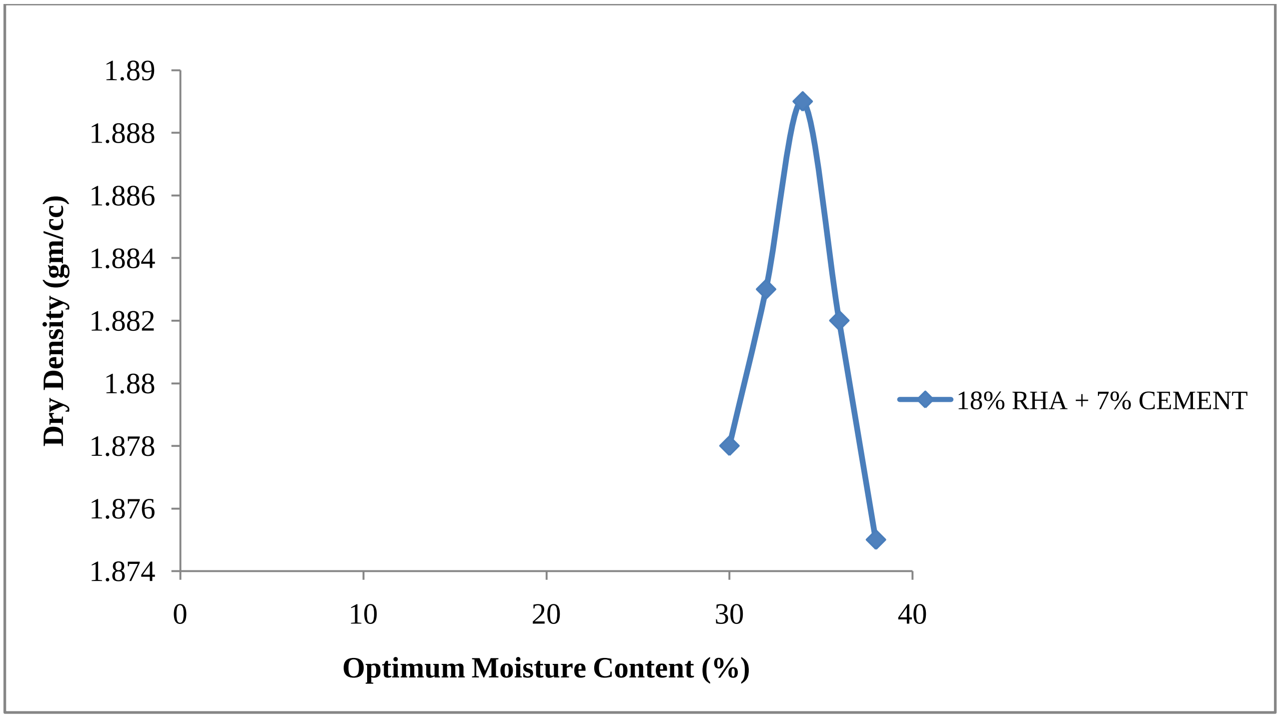

Figure 4.9: Graph showing Moisture-Density Relationship at Soil: RHA :Cement(75:18:7)

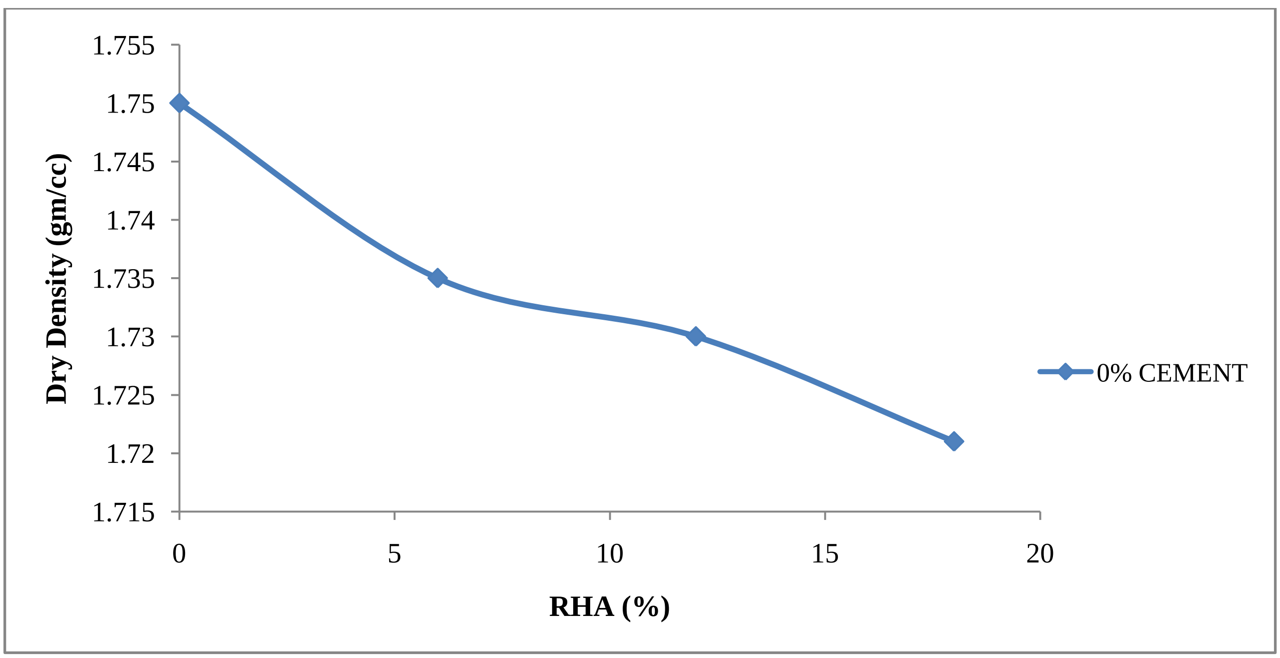

Figure 4.10: Graph showing decrease in Dry Density of Soil for different proportion of RHA at 0% Cement

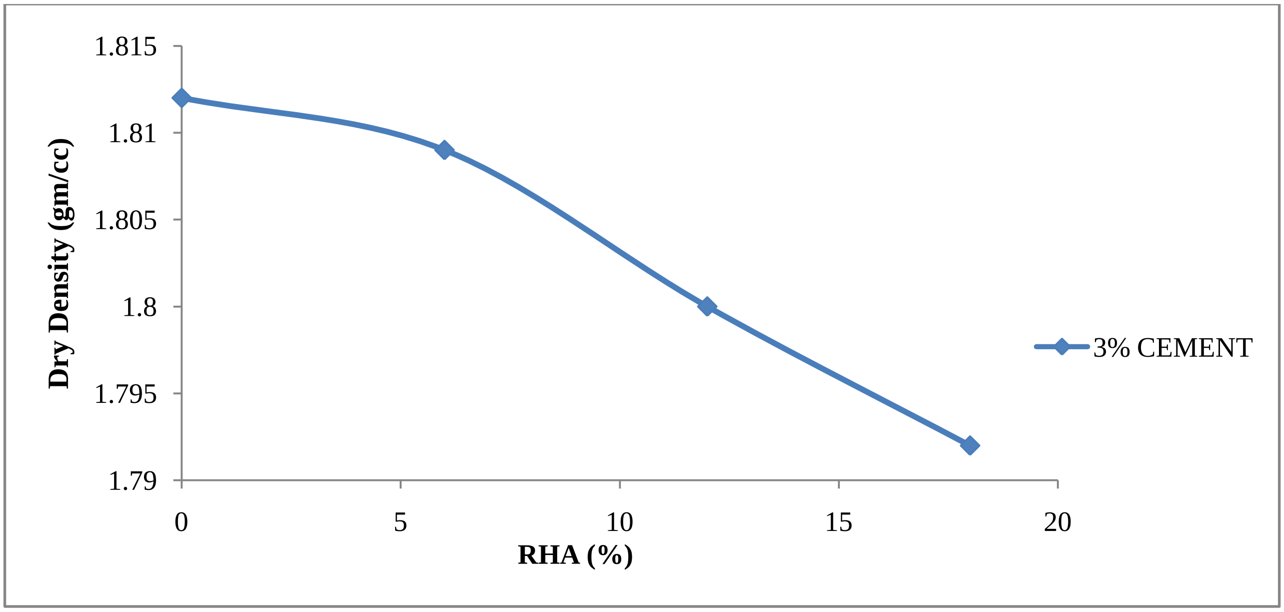

Figure 4.11: Graph showing decrease in Dry Density of Soil for different proportion of RHA at 3% Cement

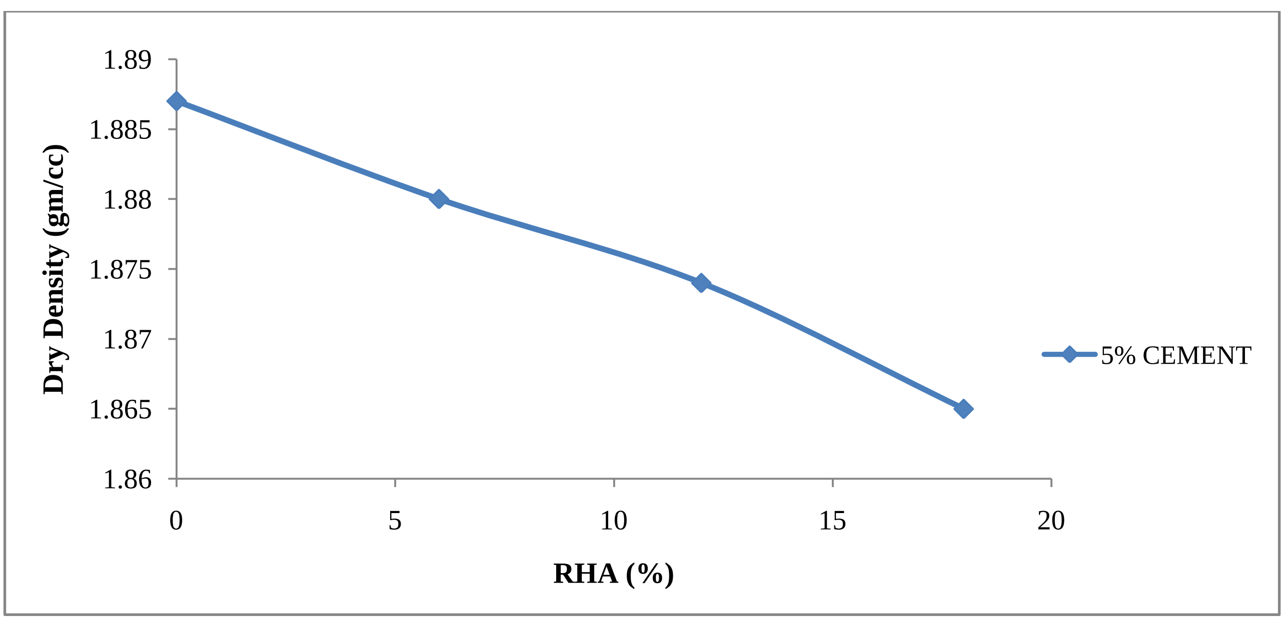

Figure 4.12: Graph showing decrease in Dry Density of Soil for different proportion of RHA at 5% Cement

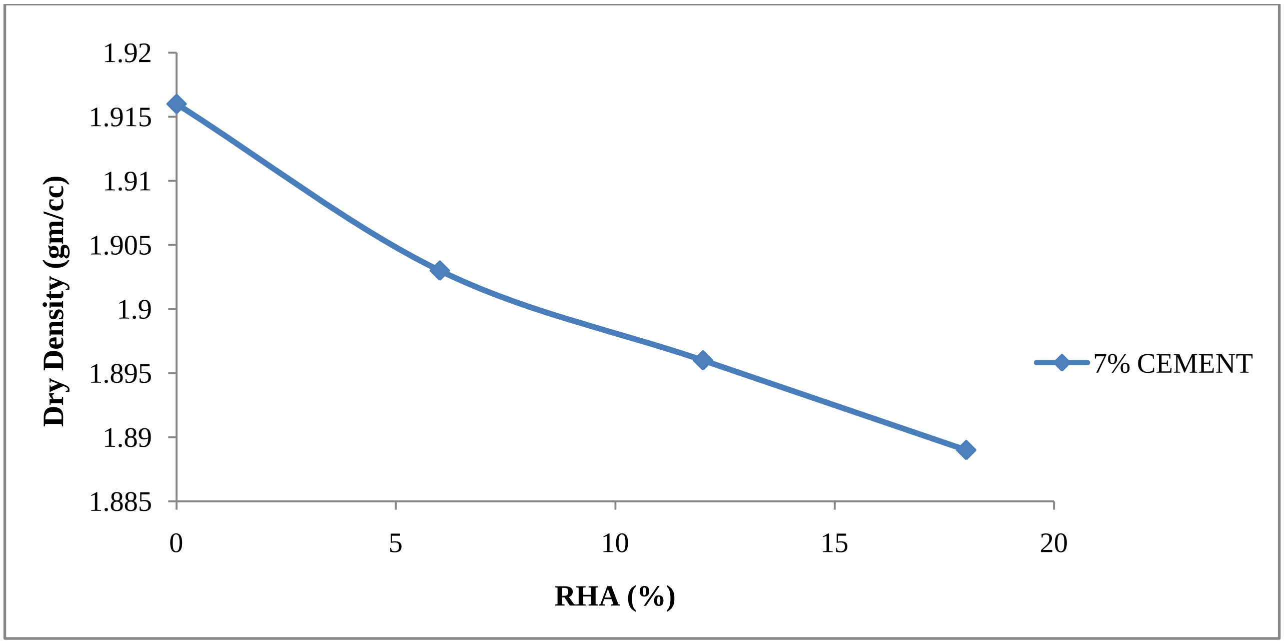

Figure 4.13: Graph showing decrease in Dry Density of Soil for different proportion of RHA at 7% Cement

4.1.1 DISCUSSION

OPTIMUM WATER CONTENT:

Optimum water content results obtained from standard proctor test on various mix proportion of Soil and Rice Husk Ash with the percentage increased of RHA the Optimum water content increased. the OWC at 6%, 12%, 18% RHA was 16.4%, 18.2% and 20.2% respectively. The Optimum water content mainly increased due to chemical reactions b/w the clay particles of soil and Rice husk ash.

Optimum water content results obtained from proctor test, it was examine that for virgin soil OWC 15.3%, which increased to a value of 17.2% with an amount of 6% RHA and 3% Cement. Further amount of RHA content 12% and 18% with 5% Cement the value of

Optimum water content increase 24.5% and 27.3% respectively. Optimum water content (OWC) is increase with increase with RHA and Cement content. the increased in Optimum water content mainly due to two reasons: first reasons mainly due to additional water held with the flocculent soil structure resulting from cement amount or more water absorption by RHA as a result of its porous properties.

MAXIMUM DRY DENSITY:

Maximum dry density of the soil is decrease with increase in RHA amount. the MDD at 0%, 6%, 12% & 18% RHA was 1.750,1.735, 1.718& 1.702 respectively. but with the amount of 3%, 5%, 7% Cement content in virgin soil MDD is increase.

4.2 CALIFORNIA BEARING RATIO TEST (CBR):

The Annual results of CBR tests are showing in the form of various graphs. Different graphs are showing among the load vs penetration to observed the most extreme values of CBR.

Table 4.1: Values of CBR At Different Proportions

Sample	Name of proportion	SOIL:RHA:CEMENT	CBR (%)
Sample 1	Soil:RHA:Cement	100:0:0	7.03
Sample 2	Soil:RHA:Cement	95:0:5	25.30
Sample 3	Soil:RHA:Cement	89:6:5	27.74
Sample 4	Soil:RHA:Cement	83:12:5	29.70
Sample 5	Soil:RHA:Cement	77:18:5	28.22
Sample 6	Soil:RHA:Cement	93:0:7	39.92
Sample 7	Soil:RHA:Cement	87:6:7	43.30
Sample 8	Soil:RHA:Cement	81:12:7	45.74
Sample 9	Soil:RHA:Cement	75:18:7	41.36

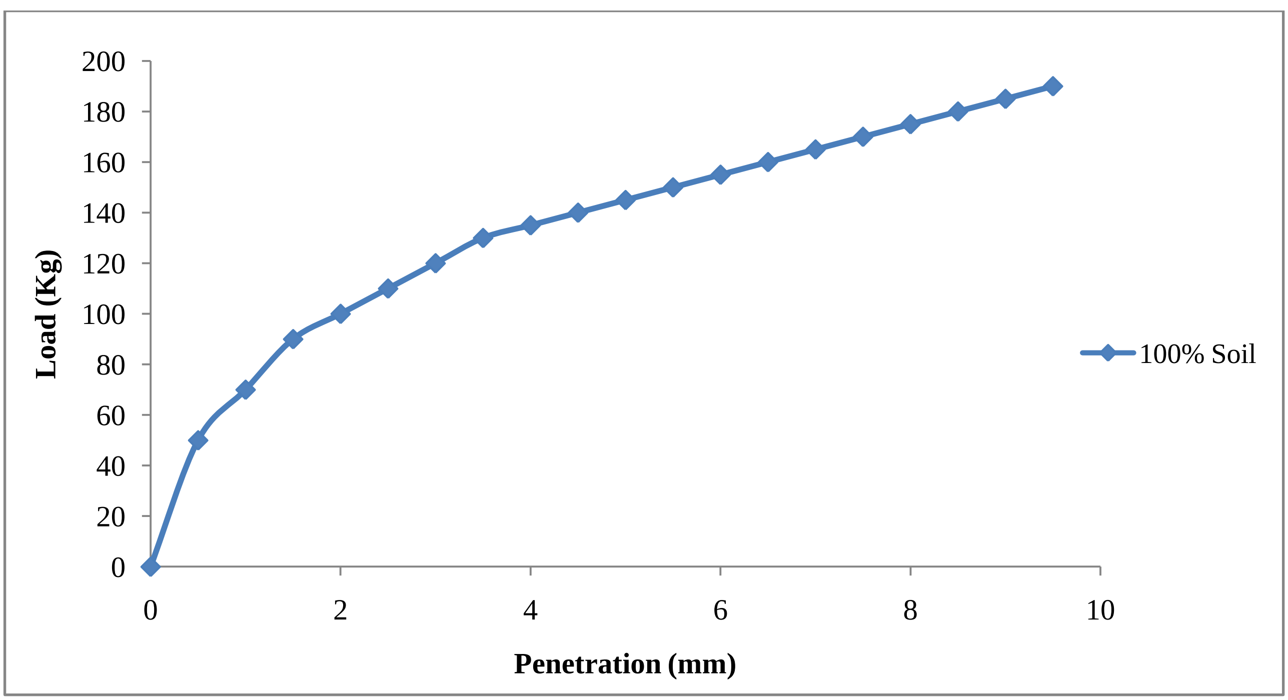

Figure 4.14: Graph showing Load-Penetration Relationship at Soil: RHA :Cement(100:0:0)

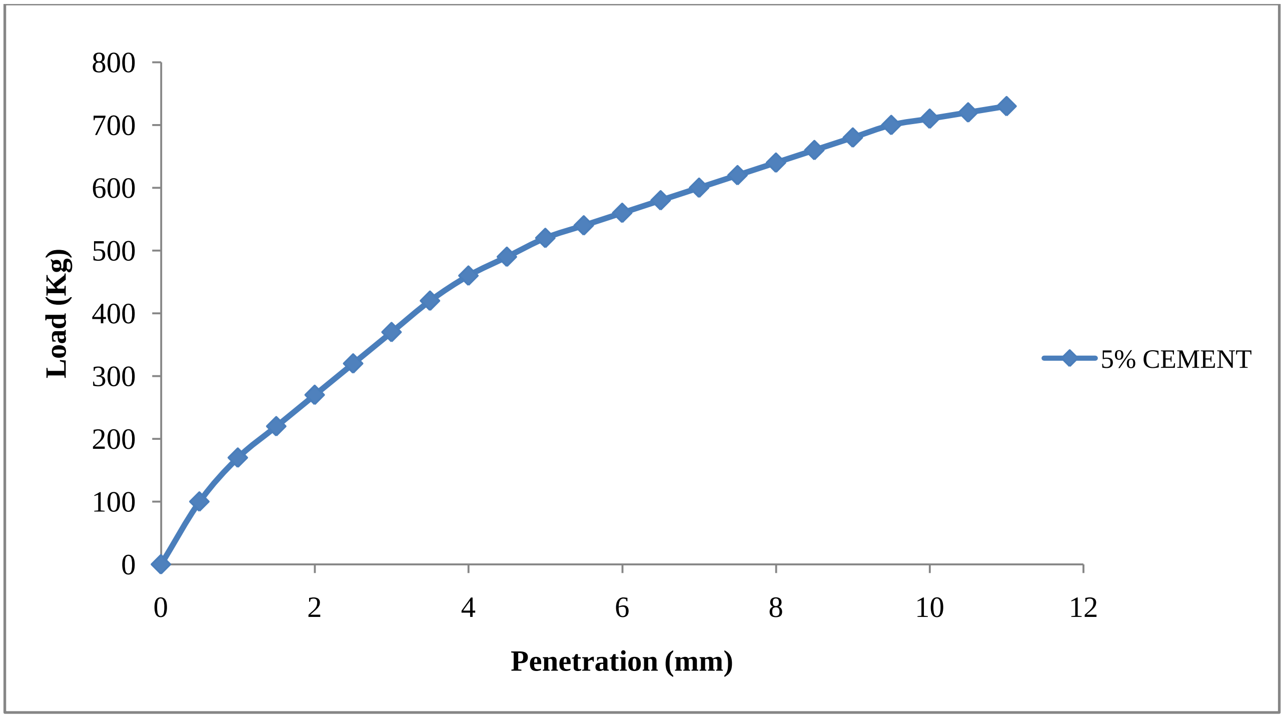

Figure 4.15: Graph showing Load-Penetration Relationship at Soil: RHA :Cement(95:0:5) mix.

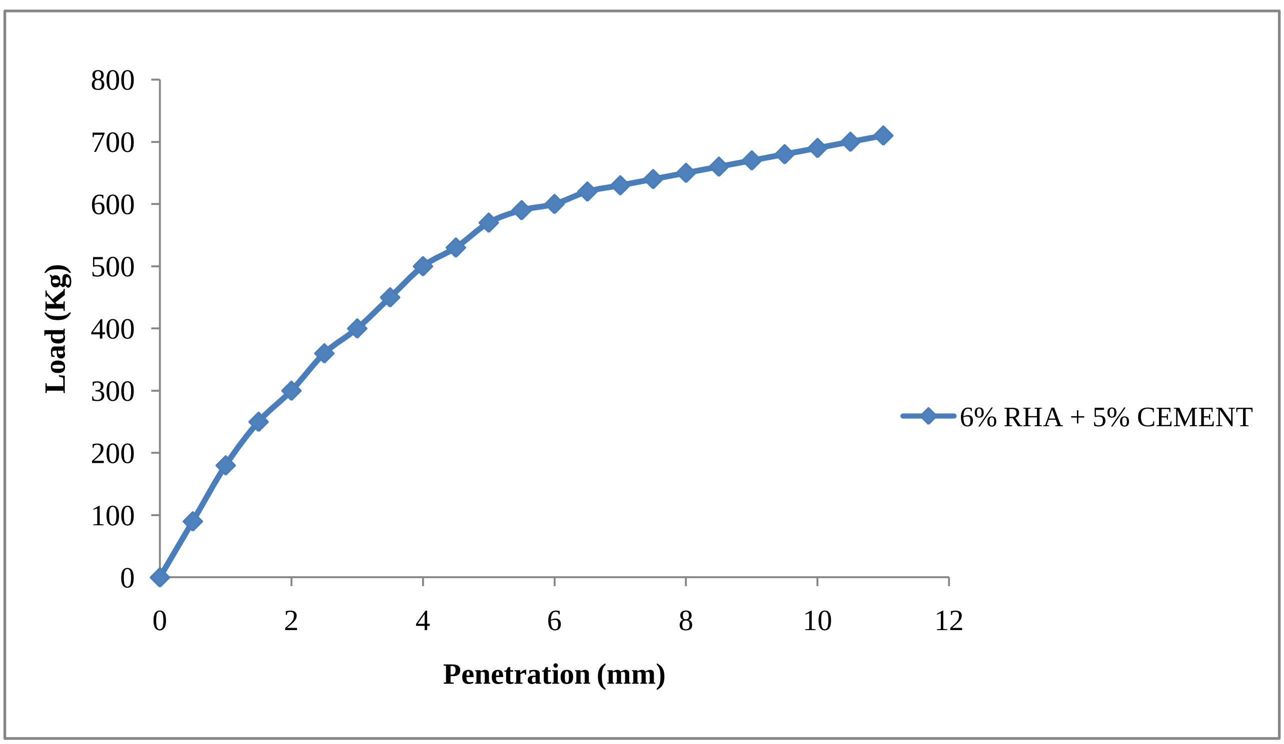

Figure 4.16: Graph showing Load-Penetration Relationship at Soil: RHA :Cement(89:6:5)

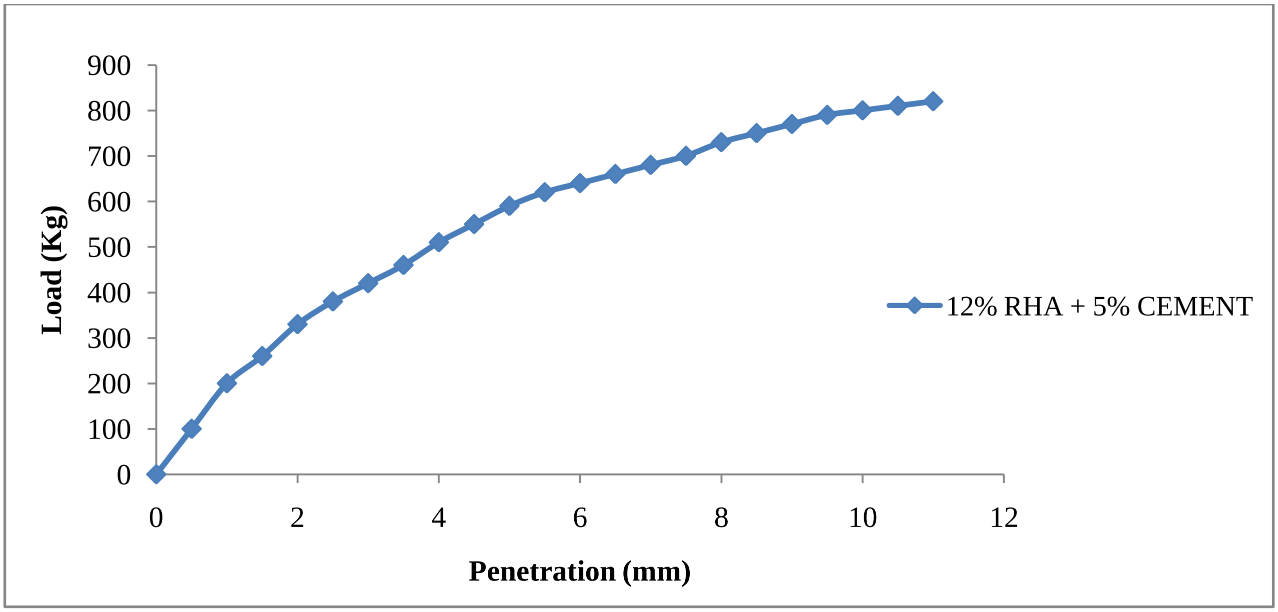

Figure 4.17: Graph showing Load-Penetration Relationship at Soil: RHA :Cement(83:12:5) mix.

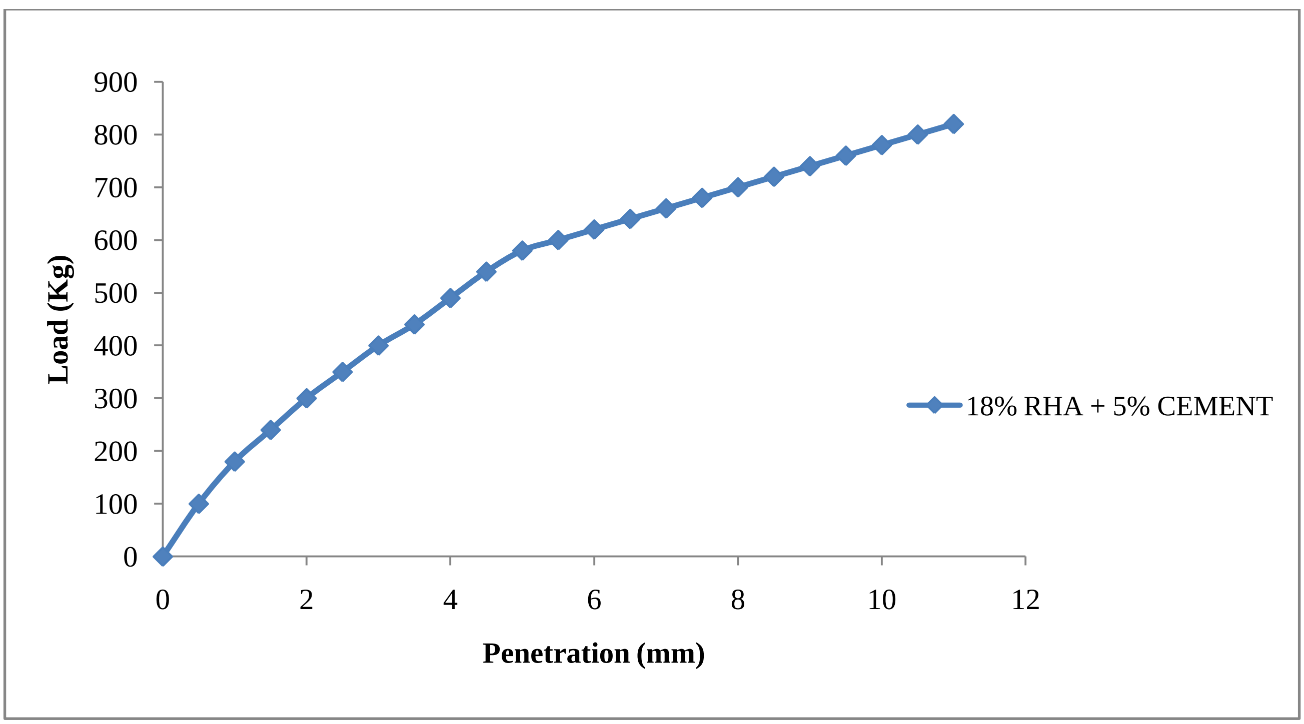

Figure 4.18: Graph showing Load-Penetration Relationship at Soil: RHA :Cement(77:18:5)

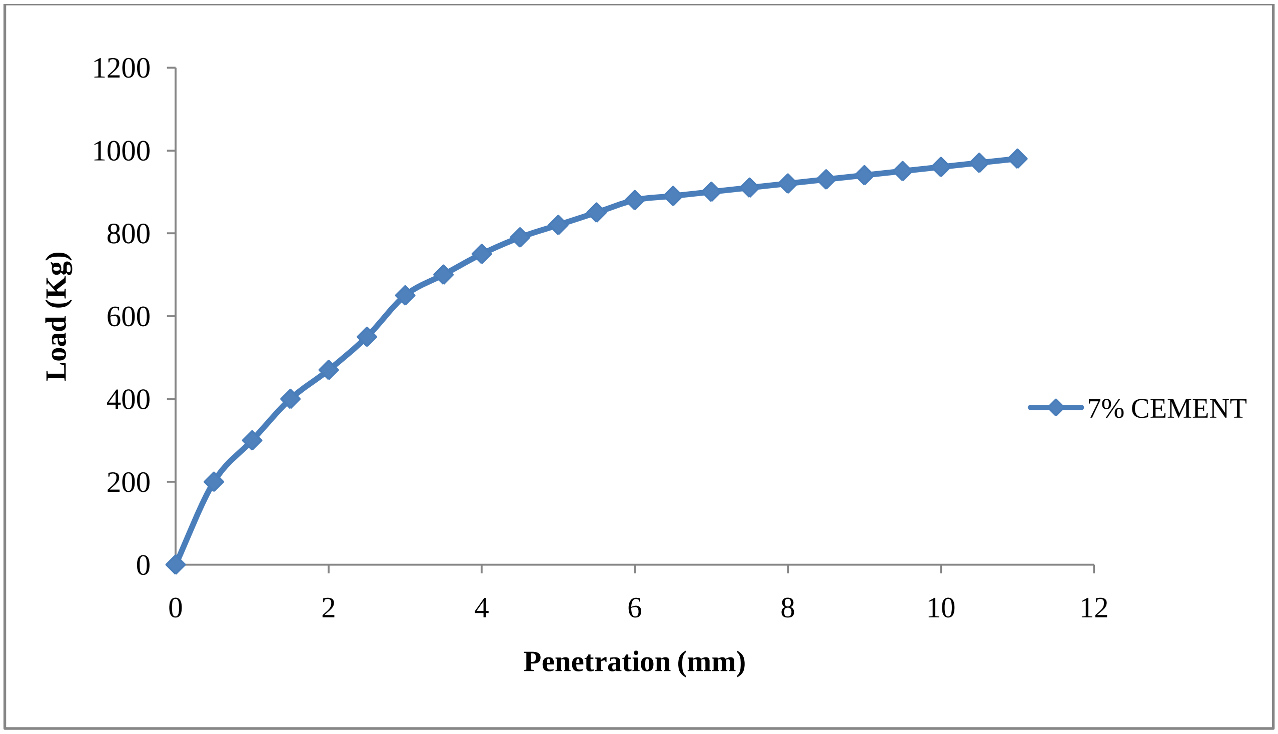

Figure 4.19: Graph showing Load-Penetration Relationship at Soil: RHA :Cement(93:0:7) mix.

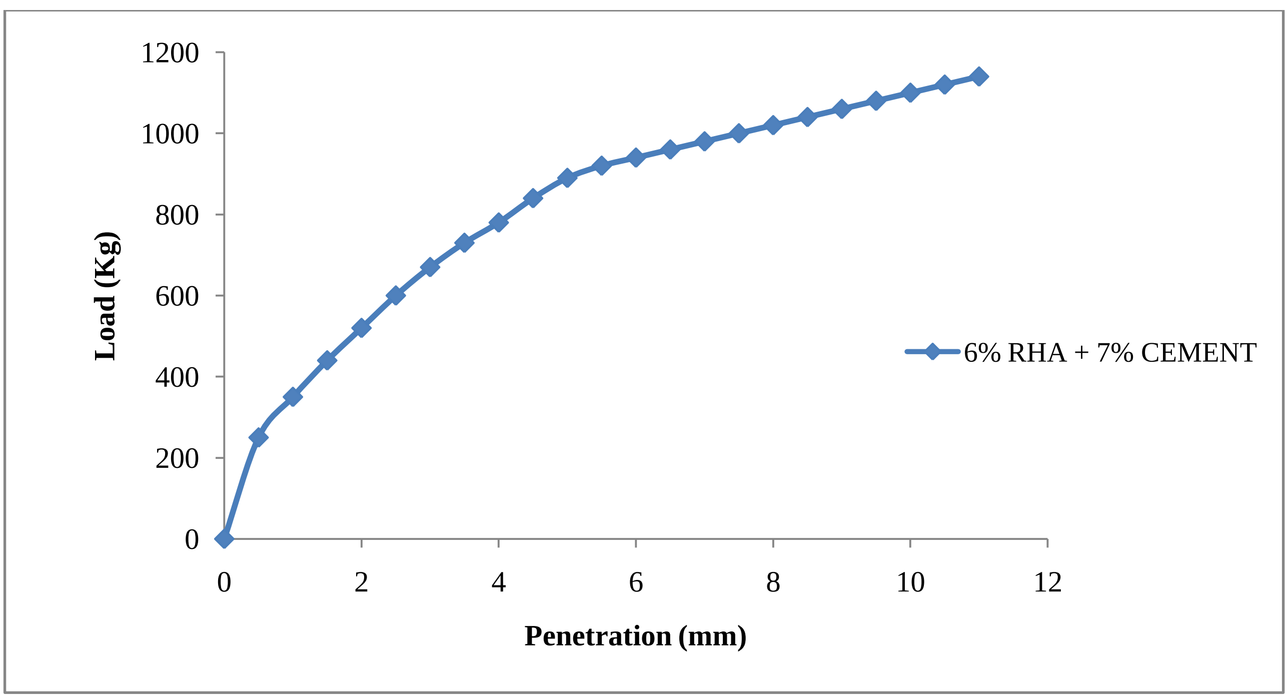

Figure 4.20: Graph showing Load-Penetration Relationship at Soil: RHA :Cement(87:6:7) mix.

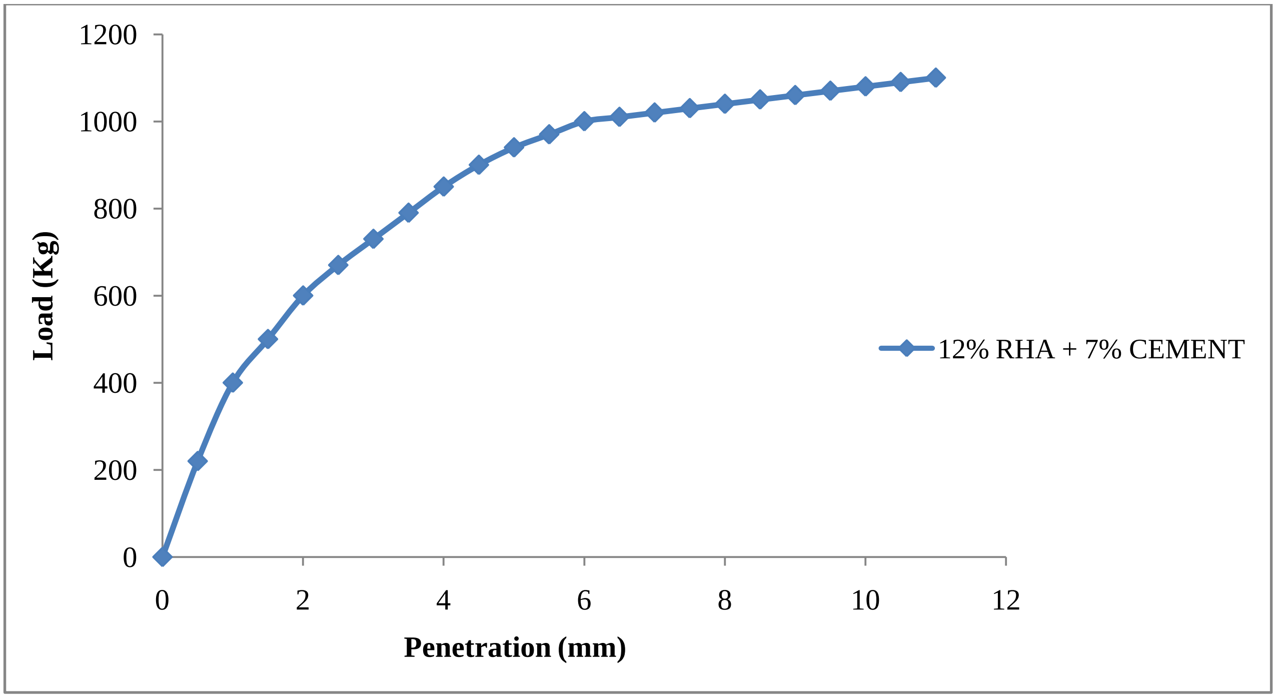

Figure 4.21: Graph showing Load-Penetration Relationship at Soil: RHA :Cement(81:12:7) mix.

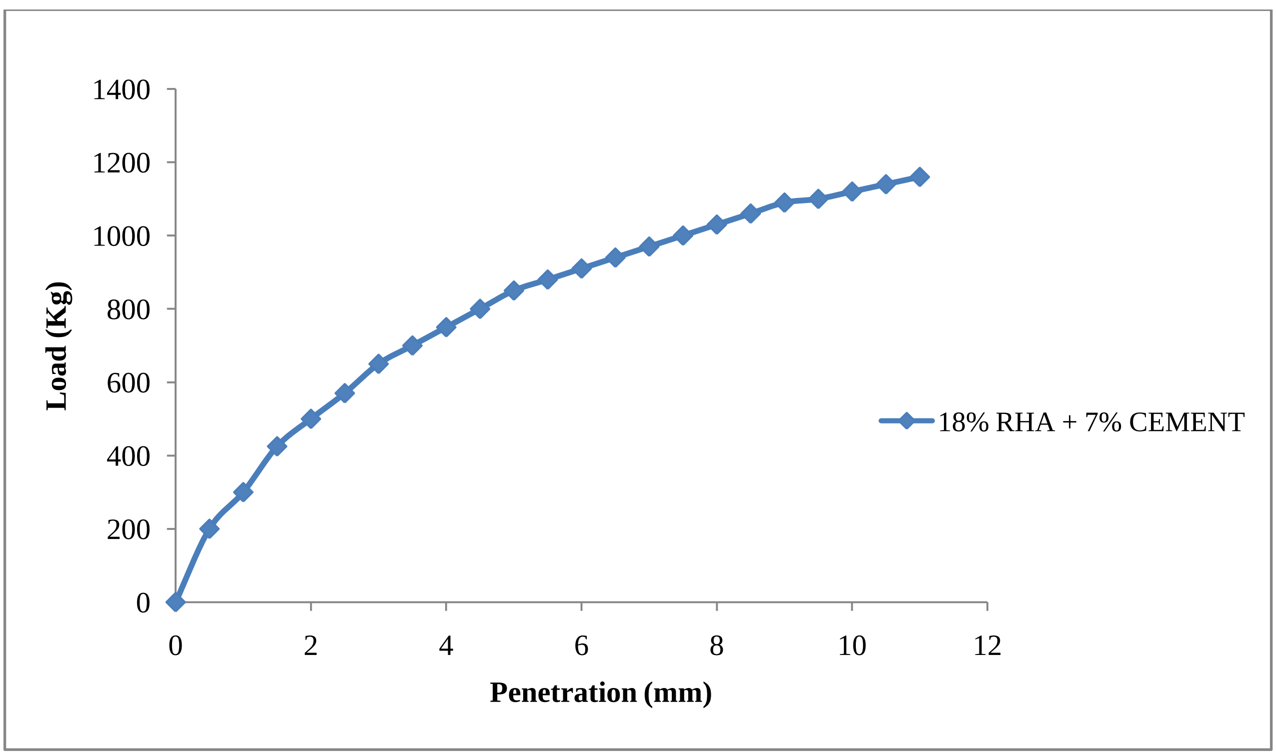

Figure 4.22: Graph showing Load-Penetration Relationship at Soil: RHA :Cement(75:18:7)

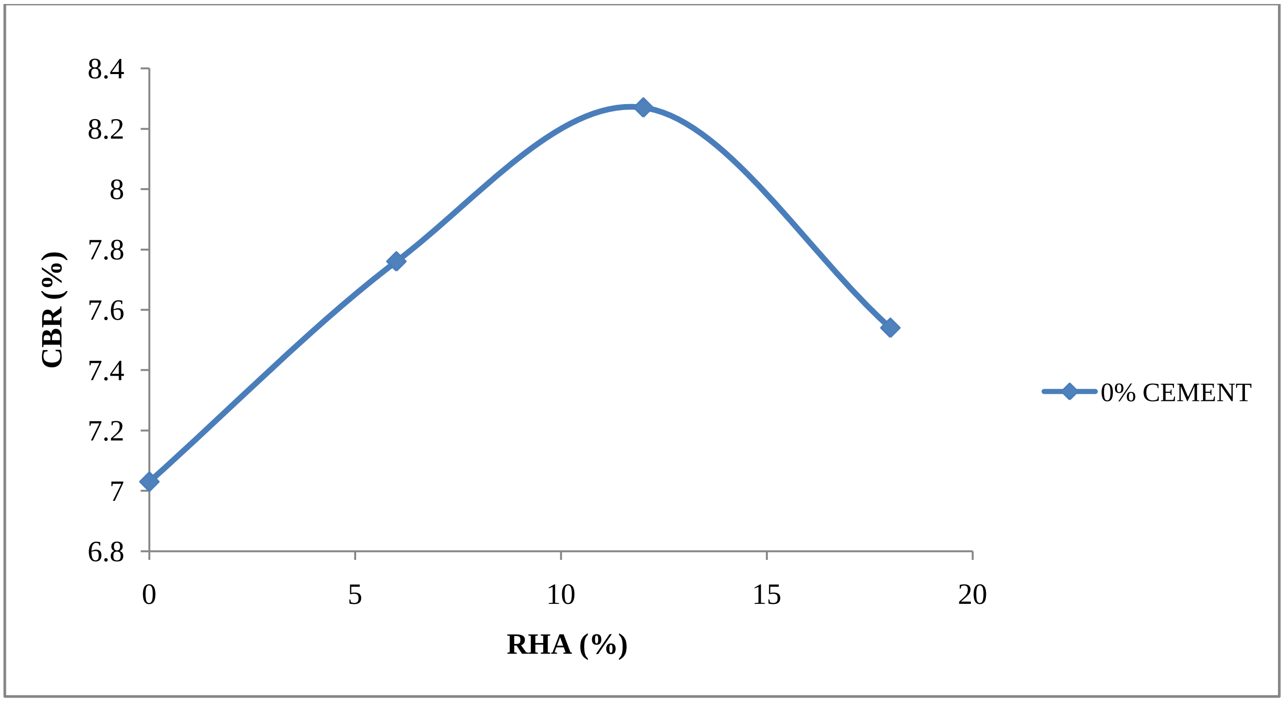

Figure 4.23: Graph showing CBR (%) - RHA (%) Relationship at 0% Cement Content

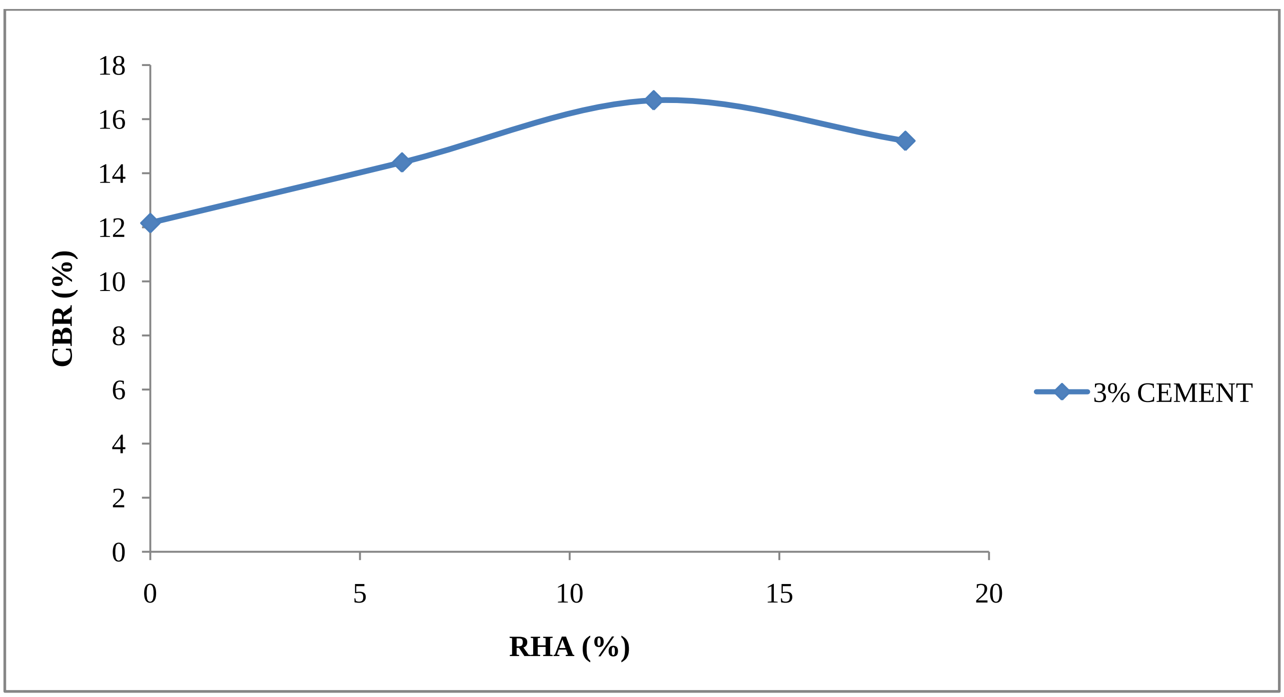

Figure 4.24: Graph showing CBR (%) - RHA (%) Relationship at 3% Cement Content

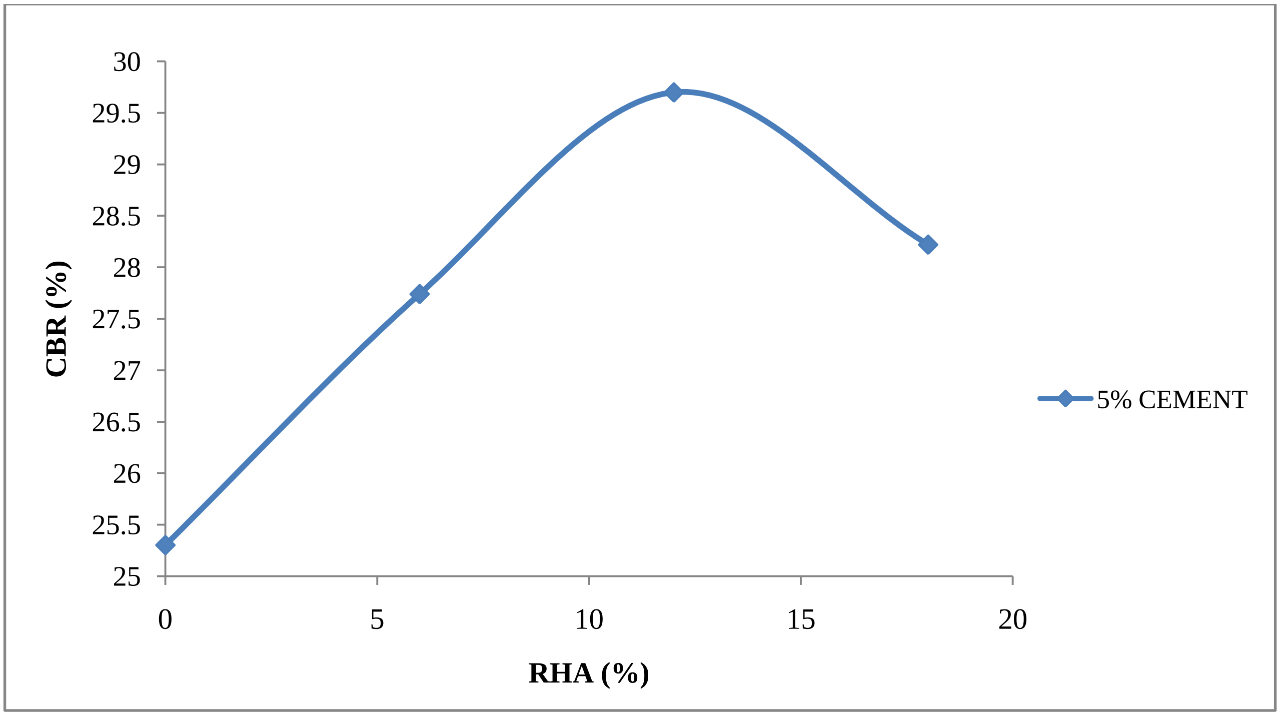

Figure 4.25: Graph showing CBR (%) - RHA (%) Relationship at 5% Cement Content

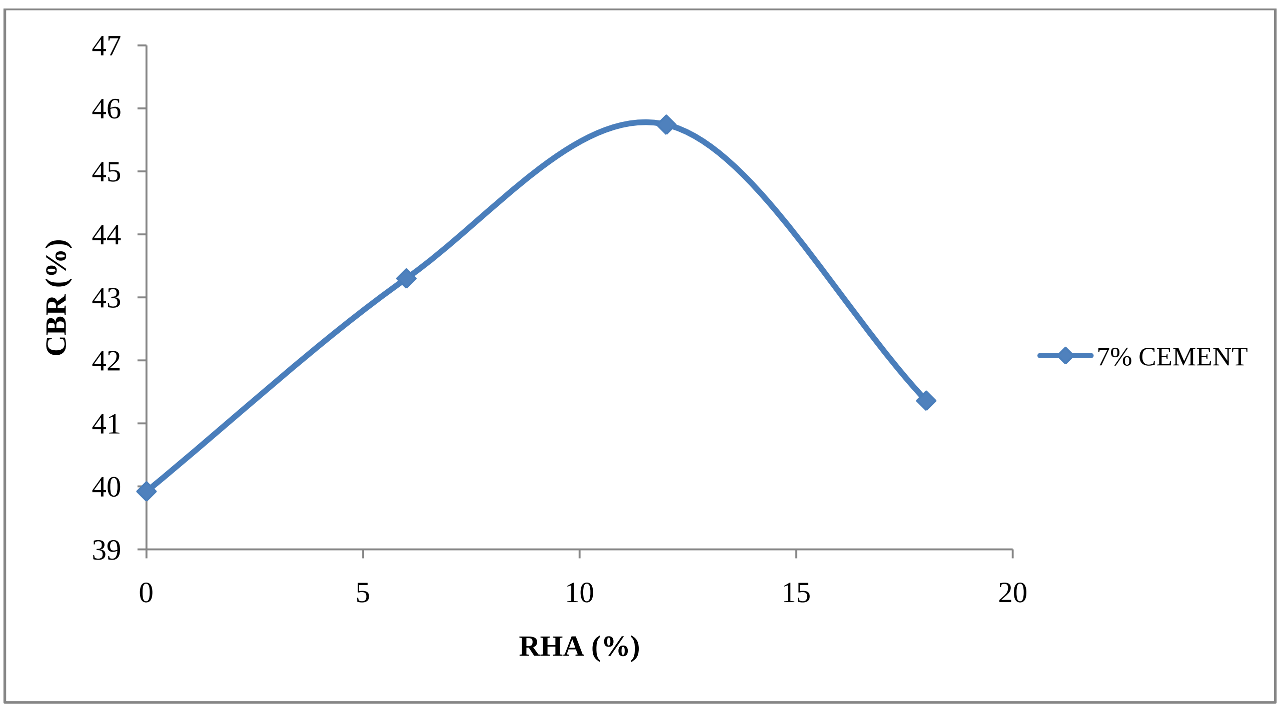

Figure 4.26: Graph showing CBR (%) - RHA (%) Relationship at 7% Cement Content

4.2.1 DISCUSSION

This understand showing that the CBR values increased by 9.69% and 14.63% while adding 6 and 12 %age RHA content in virgin soil. further increase in amount of RHA to 18% the CBR value is increased by 6.20% . In other way adding cement amount 5% and 7% to the virgin soil the CBR value is increased by 72.55% and 83.25% respectively. And while adding 6%, 12%, 18% RHA amount along with 3% cement content CBR value increased by 6.90%, 12.60%, 7.20% respectively by the samples having 3% cement amount. In other way adding 6%, 12%, 18% RHA amount along with 5% cement content CBR value increased by 8.90%, 14.68%, 9.30% respectively by the samples having 5% cement amount. While adding 6%, 12%, 18% RHA amount along with 7% cement content CBR value increased by 9.50%, 15.90%, 5.55% respectively by the samples having 7% cement amount. which represent that the RHA optimum value is 12% up to which increased the value. more %age of RHA adding in clayey soil the value of CBR decreased.

4.3 PERMEABILITY TEST

The Permeability tests results are showing in the form of tables and graphs..Calculate the coefficient of Permeability of soil for various mix proportions Soil: RHA :Cement. which showing in the table below:

Table 4.2: Values of Coefficient of permeability (K) At Different Proportions

Sample	Name of proportion	SOIL:RHA: CEMENT	Initial Ht. of water (cm)	Final Ht. of water (cm)	Time Interval (Hour)	Coefficient of permeability (cm/sec)
Sample 1	Soil:RHA:Cement	100:0:0	90	84	6	$5.29*10^{-6}$
Sample 2	Soil:RHA:Cement	95:0:5	80	73	5	$8.45*10^{-6}$
Sample 3	Soil:RHA:Cement	89:6:5	80	74.4	6	$5.58*10^{-6}$
Sample 4	Soil:RHA:Cement	83:12:5	80	75	6	$4.96*10^{-6}$
Sample 5	Soil:RHA:Cement	77:18:5	80	75.7	7	$3.63*10^{-6}$
Sample 6	Soil:RHA:Cement	93:0:7	75	66	6	$9.84*10^{-6}$
Sample 7	Soil:RHA:Cement	87:6:7	75	68	6	$7.53*10^{-6}$
Sample 8	Soil:RHA:Cement	81:12:7	75	69.2	6	$6.19*10^{-6}$
Sample 9	Soil:RHA:Cement	75:18:7	75	70	7	$4.54*10^{-6}$

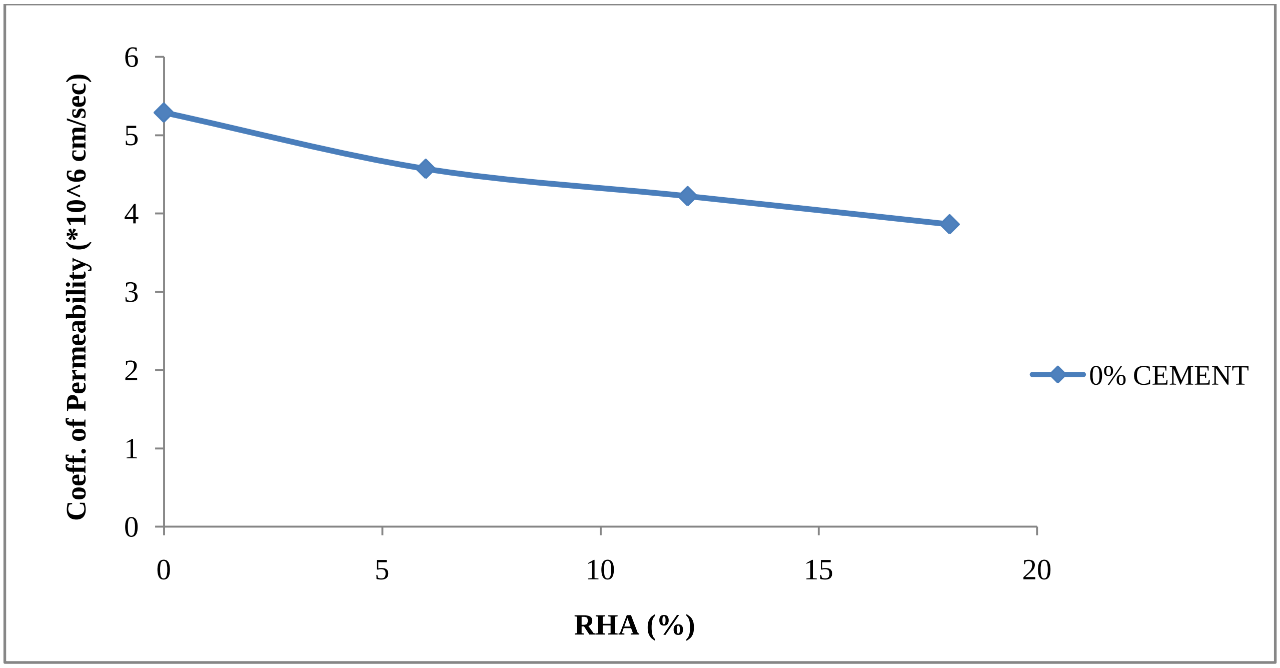

Figure 4.27 : Graph showing Coefficient of Permeability (k) for Different proportions of RHA at 0% Cement mix

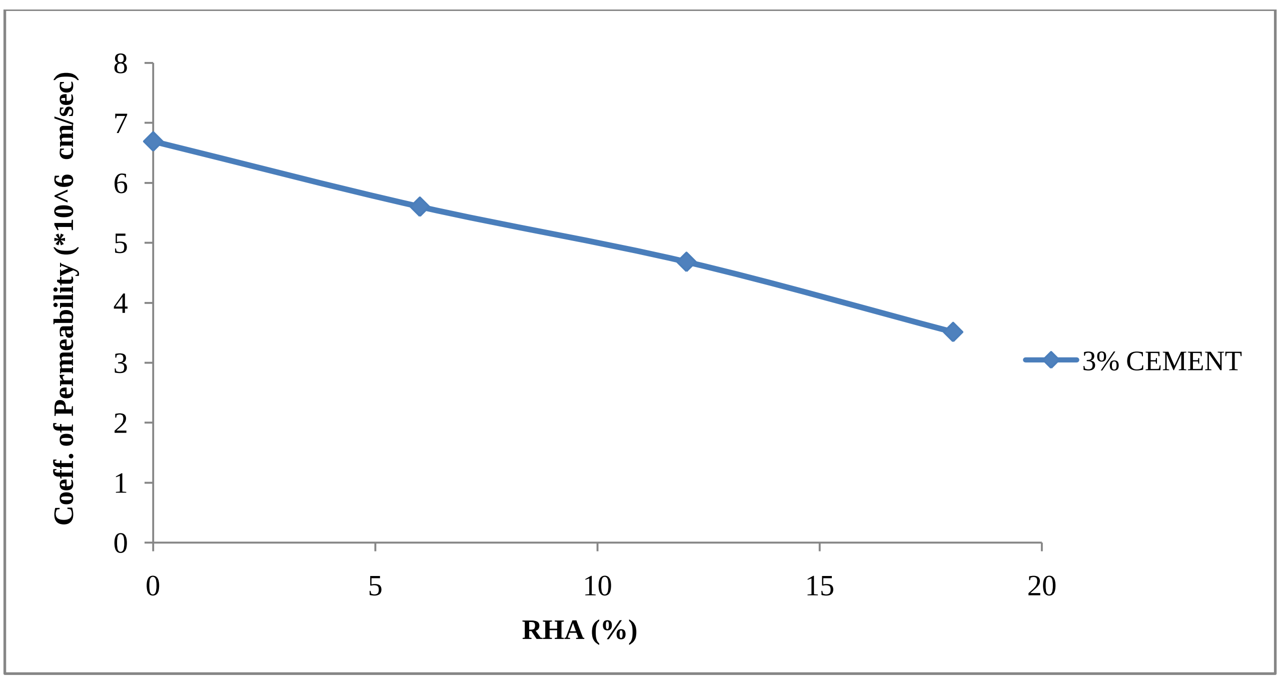

Figure 4.28 : Graph showing Coefficient of Permeability (k) for Different proportions of RHA at 3% Cement mix

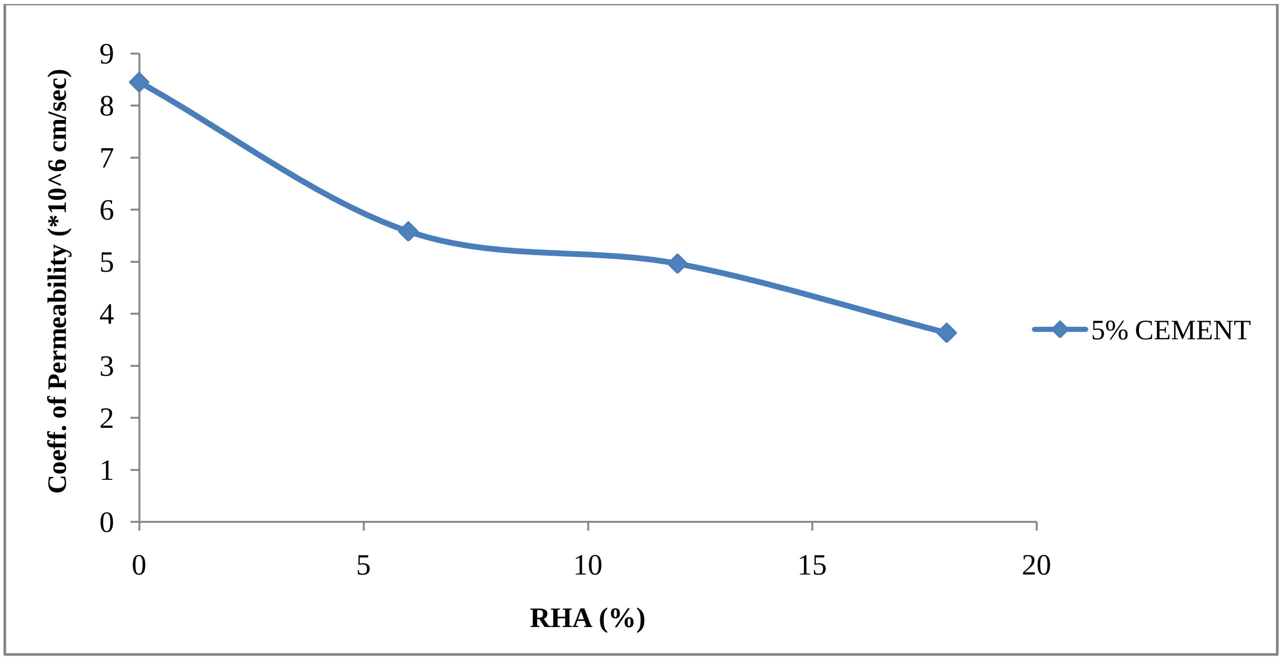

Figure 4.29 : Graph showing Coefficient of Permeability (k) for Different proportions of RHA at 5% Cement mix

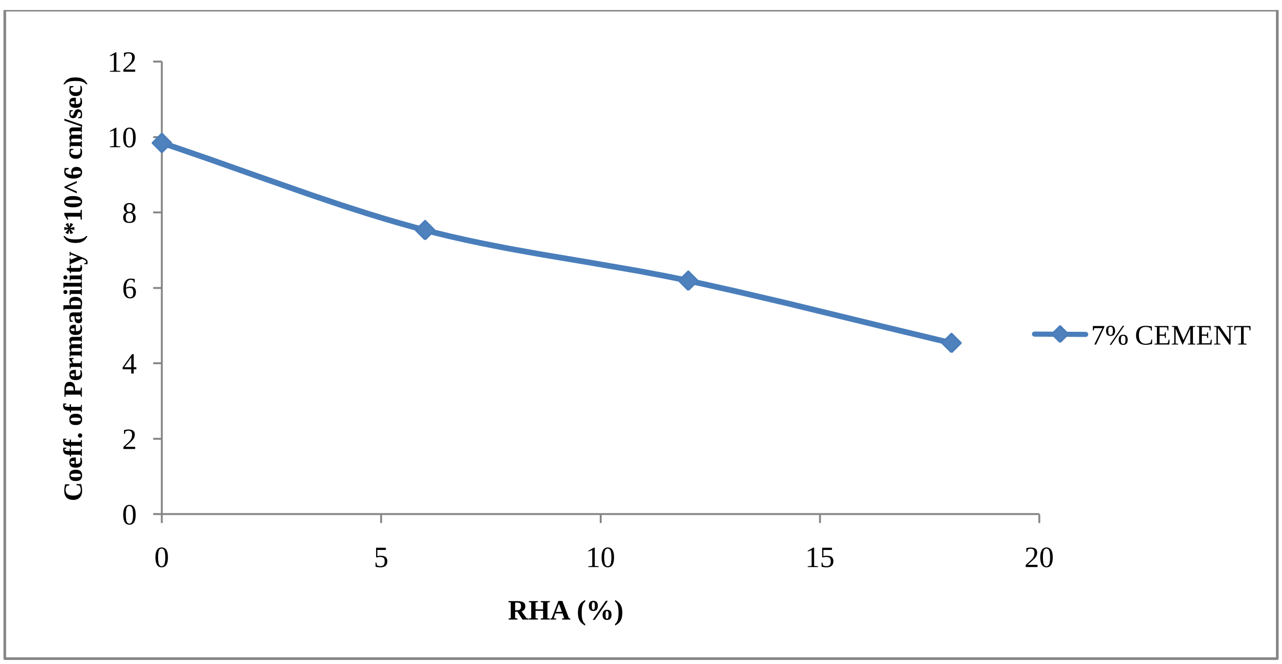

Figure 4.30 : Graph showing Coefficient of Permeability (k) for Different proportions of RHA at 7% Cement mix

4.3.1 DISCUSSION

Permeability test were performed on the different %age of RHA and Cement on clayey soil. Generally depend upon the results observed form permeability test. it is examine that for virgin soil coefficient of permeability test was $5.29*10^{-6}$. Coefficient of Permeability (k) decreased with increased RHA amount up to 6%, 12% & 18%. Further addition of Cement 3%, 5% & 7% Coefficient of Permeability (k) values is increased. Both materials adding Coefficient of Permeability (k) values is increased while RHA & Cement. Clayey soil of Coefficient of Permeability is decrease with increase amount of Rice Husk Ash. Amount of Cement makes the soil & RHA mixing slightly porous as a observed results Coefficient of Permeability (k) values is decreased.

CHAPTER 5

CONCLUSIONS AND SUGGESTION FOR FURTHER STUDY

5.1 CONCLUSION

In this thesis work, compaction characteristics of Soil - RHA- Cement mix have been observed. the mainly following conclusions can be made by various tests performed and results obtained from RHA - Cement stabilized clayey soil:

1. Rice husk ash amount is increase the Maximum dry density of soil decreases and the values of Optimum water content increases.

2. Cement amount is increase the Maximum dry density of soil increases and the values of Optimum water content decreases.

3. Maximum dry density of the soil is decrease with increase in RHA amount. the MDD at 0%, 6%, 12% & 18% RHA was 1.750,1.735, 1.718 & 1.702 respectively. but with the amount of 3%, 5%, 7% Cement content in virgin soil MDD is increase.

4. From the results examine from proctor test on various soil and RHA mixes with the increases in percentage of RHA was 16.4%, 18.2% and 20.2%.The Optimum water content mainly increased due to chemical reactions b/w the clay particles of soil and Rice husk ash.

5. It was examine that for virgin soil OWC 15.3%, which increased to a value of 17.2% with an amount of 6% RHA and 3% Cement.

6. Further amount of RHA content 12% and 18% with 5% Cement the value of Optimum water content increase 24.5% and 27.3% respectively. Optimum water content (OWC) is increase with increase with RHA and Cement content.

7. The California Bearing Ratio test values increased by 9.69% and 14.63% while adding 6 and 12 %age RHA content in virgin soil. further increase in amount of RHA to 18% the CBR value is increased by 6.20%. So it observed that maximum value of CBR is achieved at 12% RHA amount in virgin soil.

8. In other way adding cement amount 5% and 7% to the virgin soil the CBR value is increased by 72.55% and 83.25% respectively.

9. Coefficient of permeability value of virgin soil was $5.29*10^{-6}$. Coefficient of Permeability (k) decreased with increased RHA amount up to 6%, 12% & 18%. Further addition of Cement 3%, 5% & 7% Coefficient of Permeability (k) values is increased.

10. Both materials adding Coefficient of Permeability (k) values is increased while RHA & Cement. Clayey soil of Coefficient of Permeability is decrease with increase amount of Rice Husk Ash.

5.2 SUGGESTIONS FOR FURTHER SCOPE OF STUDY

Several Observation recommendations can assist in with improve the geotechnical properties of Soil - RHA- Cement mixes which can be useable for using waste products. These Program generally may be end up being aid for best used of waste products to best purchase for further analysis.

1. California bearing ratio tests are performed on various proportion of soil - RHA - Cement mixes in socked conditions.

2. Tri-axial tests are performed on various proportion of Soil - RHA - Cement mixes to define soil properties in more detail should be investigated.

3. Durability test on different proportion of Soil - RHA - Cement mixes of freezing and thawing process should be performed.

4.CBR test are also performed to understand by using Geo-textile by placing it at various heights.

REFERENCES

1. Arora, K.R "Soil Mechanics And Foundation Engineering 4th Edition".

2. Jagroop Singh "Soil And Foundation Engineering".

3. Agus Setyo Muntohar et al., (2013) "Engineering Properties of Silty Soil Stabilized with Lime and Rice Husk Ash and Reinforced with Waste Plastic Fiber". Journal of materials in civil engineering, pp. 1260-1270.

4. Alhassan, Musa et al., (2008) "Effects of Rice Husk Ash on cement stabilized laterite". Leonardo Electronic Journal of Practices and Technologies, Issue 11 , pp. 47-58.

5. Alhassan, M. (2008). "Potentials of Rice Husk Ash for Soil Stabilization". A.U J.T 11(4): 246-250.

6. Brooks, Robert, M., (2009) "Soil stabilization with fly ash and Rice husk ash". International Journal of Research and Reviews in Applied Sciences, Volume 1, Issue 3.

7. Basha ,E.A., Hashim, R., Mahmud, H.B. & Muntohar , A.S., (2004) "Stablization of Residual soil with Rice husk ash and cement" . Original research article construction & Building Material , Volume -19, Issue – 6, pp. 448–453.

8. Hwang & Chandra., (2009) "The Use of Rice Husk Ash in Concrete". Science Direct : Cement and Concrete Research 38.

9. I.S 2720 “Method of test for soil Grain size analysis”. Part IV, Bureau of Indian Standards, New Delhi.

10. I.S 4332 “Test for determination of moisture content-dry density for stabilized mixtures”. Bureau of Indian Standards, New Delhi.

11. Roy, Aparna., (2014) “Stabilization of soil using Rice Husk Ash and Cement”. International Journal of Civil Engineering Research. Volume 5, Number 1 (2014), pp. 49-54.

12. Jha , J.N. & Gill, K.S., (2006) “Effect of Rice husk ash on lime stabilization” . Journal of the Institution of Engineers (India), Volume 87, pp. 33- 39.

13. Shinghai, Kumar, Anil. et al. (2014) “ Study on soil stabilization using fly ash and rice husk ash”. International Journal of Research in Engineering and Technology, Volume: 03 Issue: 11, pp. 348-351.

14. Kumar B.Suneel et al.(2014) “Behaviour of clayey soil stabilized with Rice husk ash & lime” . International Journal of Engineering Trends and Technology (IJETT) – Volume 11.

15. Kolias et al.(2005), “Stabilization of clayey soils with high calcium fly ash and cement”. Cement and Concrete Composites, Vol. 27, pp. 301-313.

16. Kishore, Garima, Pandey et al. (2015) , " Soil Stabilization by using Rice Husk Ash and lime on sandy soil" International Journal of Innovative Research in Science, Engineering and Technology - Volume 4.