**STABILIZATION OF BLACK COTTON SOIL USING LIME AND QUARRY DUST AS A ADMIXTURES**

Minor Project Report

Submitted in the partial fulfillment of the requirements for the

Award of the degree of

**BACHELOR OF TECHNOLOGY**

**IN**

**CIVIL ENGINEERING**

**KL UNIVERSITY**

**BY**

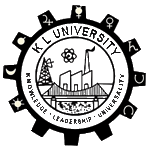
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<NOVEMBER, 2019-2020>

# CERTIFICATE

This is to certify that the project report entitled “**STABILIZATION OF BLACK COTTON SOIL BY USING QYARRY DUST AND LIME MIXTURE”** submitted by **M. SAI NANDAN, K. DEVANAND,** with register numbers **160020067, 160020059,** of IV/IVB.Tech submitted to KL University in partial fulfillment of the completion of course for the award of the Degree **BACHELOR OF TECHNOLOGY** in **CIVILENGINEERING** is a Bonafide record of the work carried out under my guidance and supervision at KL University during the academic year 2019-2020.

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**DECLARATION**

We declare that this written submission represents our ideas in our own words and other’s ideas or words have been included, we have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission. We understand that any violation of the above will be cause for disciplinary action as per the rules of regulations of the institute.

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**Place: Guntur**

**Date: 04-04-2020**

**ACKNOWLEDGEMENT**

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**ABSTRACT**

Soil stabilization is a system to treat the soil to maintain, adjust or improve the performance of the soil. In this look at , the capacity of rice husk ash as stabilizing additive to expansive soil is evaluated for the enhancing engineering properties of expansive soil.

TheAssesmnet involves the dedication of the swelling potential, linear Shrinkage, Atterberg’s limits, &compaction take a look of expansive soil in its herbal nation in addition to whilst mixed with various percentage of quarry dust and lime mixture (2% to 10%). the practices were executed on 5 proportions 5%,10%,15%, 20% and 25% with the sample. With growing amount of stabilizers swelling quantity decreases.

Expansive clayey soils(BC Soils) are very problematic soils and not suitable for construction. Because change in volume when it expose to water . Usually in monsoon they absorbs water and swells and in summer it shrinks. Due to these reasons they varies their volume, And also it result in failure of substructure in the form of cracks and settlement of soil. Based on these critical conditions this type of soils are mixed with some admixtures (waste materials) like Quarry dust and Lime mixture.

Liem mixture is having high lime content. So it is used as chemical stabilizer. It will increase the shearing and bearing capacity of soil due to increase in chemical bonding in soil and also Lime is occupies the voids created by coarser particles.

• Stabilization of Black cotton soil.

• Optimum use of admixtures to enhance the geotechnical properties of Black cotton soil.

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**CHAPTER I**

**INTRODUCTION**

* 1. **General**

Stabilization contains the systems used for enhancing the properties of soil to upgrade its making plans execution. In the advancement of avenue and runway keeps, the critical focus on stabilization is to collect the fine or soundness of soil and to decrease the develpoment value by making first-rate utilization of the locally availble materials.

In these study an attempt has made to investigate the efficiency of Quarry dust and Lime mixture to stabilize black cotton soil. Varying proportions of quarry dust and lime mixture was added and determined the basic geotechnical properties such as specific gravity, compaction, unconfined compressive strength, maximum dry density.

It has been observed that the addition quarry dust and lime mixture did not alter the plasticity characteristics of the soil. Compaction tests revealed that maximum dry density and optimum moisture content increases with these two admixtures. At one point the maximum dry density and optimum moisture content decreases by adding of quarry dust and lime mixture.

The basic principles in soil stabilization may be states as:

1. Evaluating the properties of the given BC soil.
2. Designing the stabilized soil mix for expected stability and durability values.
3. Considering the construction producer by adequately compacting the stabilized layer.

The energy residence of these soil alternate acccording to the amount of water contained in the voids of the soils. The engineering behaviour of satisfactory-grained soils relies upon on their water content.

**1.2 BLACK COTTON SOIL:**

Soil is the indispensible element of the nature. Black cotton soil is the major soil group in India. The most critical characteristic of the soil is, when dry, it shrinks and is hard like stone and has high bearing capacity. Immense parts are confined in the weight of the soil. The whole region isolates and obtain cracks up to 150 mm wide and depth of 3.0 to 3.5 meter. In any case, when the soil is exposed to moisture it becomes very soft and loose and the bearing capacity of the soil is decreased. These soils are observed mostly in the central and western parts of India and covers 20% of the total area of the land and one of the major soil deposits in India.



Fig. No. 1

**1.3 QUARRY DUST:**

Quarry dust is the waste and the byproduct obtained by the process of crushing of aggregates used for the concreting process especially as fine aggregates. In crushing activities stone is crushed into various sizes during the process along with stone of required size, the dust is also generated is called quarry dust. Quarry dust is of size in the range of 0 – 4.75mm obtained as a byproduct in the later stages of crushing of igneous rock, sedimentary rock.



Fig. No. 2

**1.4 LIME MIXTURE:**

Lime is a calcium-containing inorganic mineral made fundamentally out of oxides, and hydroxide, for the most part calcium oxide or potentially calcium hydroxide. It is likewise the name for calcium oxide which happens as a result of coal-crease fires and in adjusted limestone xenoliths in volcanic ejecta.[1] The word lime starts with its soonest use as building mortar and has the feeling of staying or adhering.



Fig. No. 3

**CHAPTER II**

* 1. **REVIEW OF LITERATURE**

1. **Stabilization of Black cotton Soil using quarry dust and lime mixture**
2. **Abhishek , K. Adarsh , N. Harsha (2007)**

The main objective of this investigation had been focused on the index properties and unconfined compressive strength behaviour of the soil stabilised with quarry dust and lime mmixture and to determine the appropriate percentage of quarry dust with 5%,10%,15%,20%and 25% keep the lime mixture content as 5% throughout the study.

1. **Soil Stabilization using Quarry dust and Lime mixture**

**Abarajithan. G, Rishab Kumar. P, Srikanth. R**

The main objective if this project or to research work are to do soil stabilization by using Quarry dust and Lime mixture in order to increase the strength of the soil , its resistance to weathering process and soil permeability. Since less work found to be done in this regard therefore the authors have take up this work. And also it performance can be increased by additives quarry dust and lime mixture.

1. **Effect of Quarry dust on Soil Stabilization (2014)**

**Qasim et al. , Mr. Dharmendra ,**

They concluded that lime mixture, with the presence of humidity, reacts with chemicals and improves strength and compressibility nature of soil.The study is conducted on locally available i.e expansive soil mixed with varying percentage of lime mixture. Soil samples for California bearing ratio (CBR) test are prepared at its maximum dry density (MDD), corresponding to its optimum moisture content (OMC), in the CBR mould without and with lime mixture. The percentage of lime mixture by dry weight of soil is taken as 0.25%, 0.5%, 0.75% and 1%. Corresponding to each lime mixture content unsoaked and soaked CBR tests are conducted in the laboratory. Tests result indicates that both unsoaked and soaked CBR value of soil increases with the increase in lime content.

Soaked CBR value increases from 3.9% to 8.6% and unsoaked CBR value increases from 8.1% to 13.2% of soil mixed with 1% lime mixture. Adding of lime mixture results in less thickness of pavement due to increase in CBR of mix and reduce the cost of construction and hence economy of the construction of highway will be achieved. The compaction test results showed a decrease in OMC from 13.65% to 12.60% and increase in MDD values from 1.85 g/cc to 1.90 g/cc.

1. **EXPERIMENTAL STUDY ON SOIL STABILIZATION BY USING QUARRY DUST AND LIME MIXTURE**

**Dr.E.Ravi&Mr.D.Sakthivel ,B.KalaNandhini, K.S.Krithiga,**

The Quarry dust for improving soil property because they are cheap, locally available and eco-friendly.In this study the stabilizing effect of quarry dust (natural waste) on soil properties has been experimentally studied. Soil samples for California bearing ratio (CBR) test are prepared at its maximum dry density (MDD), corresponding to its optimum moisture content (OMC), in the CBR mould without and with quarry dust.

The outer covering of dusty material of a matured , termed crushing process, is the reject of igneous rock. The dust is are normally 0-4.75 mm.

**CHAPTER III**

**OBJECTIVES :**

1. To know the various properties of Black cotton soil (BC).
2. To find the physical properties and Engineering properties of Black cotton soil (BC).
3. To study the interaction behavior of Black cotton soil (BC)with admixtures.
4. To improve the bearing capacity of Black cotton soil (BC).
5. To improve the various strength characteristics of Black cotton soil (BC) using admixtures.

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3. ATTERBERG LIMITS ( LL,PL& SL).
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4. STANDARD PROCTOR TEST

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**PHYSICAL PROPERTIES RESULT TABLE:**

|  |  |  |
| --- | --- | --- |
| **S.NO** | **EXPERIMENT NAME** | **RESULTS** |
| **1.** | **SPECIFIC GRAVITY** | **2.67** |
| **2.** | **SIEVE ANALYSIS** | **40.70%**  **(SILTY CLAY)** |
| **3.** | **MOISTURE CONTENT** | **19.68 %** |
| **4.** | **LIQUID LIMIT** | **45%** |
| **5.** | **PLASTIC LIMIT** | **22.6%** |
| **6.** | **PLASTICITY INDEX** | **22.4%** |
| **7.** | **FREE SWELL INDEX** | **86%** |

**Experiment No: 1**

**DETERMINATION OF SPECIFIC GRAVITY OF SOIL SOLIDS**

**As per IS 2720 Part III/Sec-l-1980**

**AIM:** To determine the specific gravity of the soil solids

**THEORY:**

The specific gravity (G) of soil solids is defined as the ratio of density of soil solids

in air to the density of equal volume of water at reference temperature of 4 °C. The specific

gravity of soils finds its applications in transforming unit mass to unit volume relations

and in computing earth pressures, settlement and stability problems in soil engineering.

The specific gravity of soil mass determination inherently assumes grains of average size

in a given soil sample and does not react with water. If all the internal voids on soil

particle are excluded for determining the true volume of soil solids, the specific gravity

obtained is called absolute specific gravity. The apparent or mass specific gravity denotes

the specific gravity of soil mass.

Generally, the value of specific gravity ranges between 2.65-2.8 for most of the soil.

For coarse-grained soils (clean sands and silts) lower values of G in the range between 2.65-

2.68 can be observed. The presence of organic matter leads to very low values of G

rich with iron or mica compositions exhibit high values of G between 2.75-2.85.

**DENSITY BOTTLE METHOD :**

Density bottle method is preferred method of determining specific gravity of finegrained soils, with more than 90% passing 2 mm-IS sieve. However, this method can also

be used for medium and coarse-grained soils, with more than 90% passing 2 mm-IS sieve.

**APPARATUS**:

1. Density bottle of 50 ml capacity with stopper

2. Hot plate capable of maintaining a temperature of 105° to 110°C

3. Water-bath maintained at constant temperature (27°C) to within ± 0.2%°C

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4. Desiccator

5. Vacuum pump,

6. Scale or weighing balance to an accuracy of 0.0001 g

7. Thermometer

8. Spatula/ Glass rod

**PROCEDURE:**

1. Wash the density bottle with the help of distilled water or acetone or alcohol-ether

mixture and dry it in an oven at 105° to 110°C or by blowing hot air in side the bottle for

some time. Cool it in the desiccator.

2. Record the mass of empty bottle with stopper to nearest 0.001 g (M1).

3. Take 50g soil sample that is ground and passing through IS sieve size of 2-mm

aperture. 15-20g of sub-sample should be filled in the density bottle and oven-dried at

105° (Note: If there is any reason to believe that this will change the specific gravity

due to loss of water of hydration the soil should be dried at not more than 80°C.

However, this fact should be reported in the record sheet). Cool the hot dried soil

sample in the desiccator and record the mass of density bottle with stopper and dry

soil sample (M2).

4. Add de-aired (air-free) distilled water to the dry soil sample little excess than to cover

the soil (Note: For soils containing soluble salts, solutions like kerosene or paraffin

oil or white spirit may be preferred).

5. Remove the entrapped air by attaching the density bottle to a vacuum pump for at

least 10 minutes. During this time, gently agitate the soil mass and water mixture by

carefully shaking and turning the bottle. For effective removal of entrapped air,

simultaneous heating on hot plate until couple of porklings observed will be preferred.

(Alternatively, the entrapped air can also be removed by boiling the density bottle

placing it in a sand bath and stirring the water soil mixture gently with the help of

spatula). Remove the stopper while boiling.

6. After de-airing process is completed, add distilled water carefully up to the level of

the volume mark provided on the density bottle.

7. Immerse the bottle up to the neck in constant temperature bath for approximately 1

hour or until it has attained the constant temperature. If there is, an apparent decrease

in the volume of the soil in the bottle is observed, remove the stopper, add more water

to the bottle, and replace the stopper. Again, place the bottle in the water bath and

allow sufficient time to ensure that the bottle and its content attain the constant

temperature.

8. Remove the bottle from the water bath, wipe it clean and dry it from outside.

9. Record the temperature of the suspension (Tt°C) and mass of density bottle with

water soil mixture and stopper (M3).

10. Empty the contents, clean it thoroughly, and fill with distilled water up to the level of

volume mark provided on the density bottle and insert the stopper.

**OBSERVATIONS AND CALCULATIONS:**

Weight of density bottle W1=667gm

Weight of bottle + dry soil W2=983gm

Weight of bottle +soil+ water W3=1696gm

Weight of bottle + water W4=1612gm

Specific gravity=W2-W1/ (W4-W1)-(W3-W2) =2.69

**RESULTS:**

Specific Gravity = 2.67

**Experiment No: 2**

**GRAIN SIZE ANALYSIS – MECHANICAL (DRY AND WET SIEVE) METHOD**

**As per IS 2720 (Part 4)-1985**

**AIM:** To establish the grain-size distribution curve of a given soil by mechanical sieve

Method.

**THEORY:**

Soil consists of an assemblage of discrete particles of various sizes and shapes.

Grain size analysis or particle size analysis is meant to group particles of similar behavior

into separate size ranges. Grain size analysis expresses quantitatively the relative

proportions, by mass, of various size ranges of particles present in the soil. The results of

a grain size analysis graphically represented in the form of a Grain Size Distribution

(GSD) curve/ Particle Size Distribution (PSD) curve/ Gradation curve. The grain size

analysis is widely used in classification of soils. The data obtained from grain size

distribution curves is used in the design of filters for earth dams and to determine

suitability of soil for road construction, air field etc. Information obtained from grain size

analysis can also be used to predict soil water movement although permeability tests are

more generally used.

**Table: Particle Size Distribution (as per ISC system)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Gravel (mm) | Coarse | Medium | Fine | Silt (mm) | Clay(mm) |
| > 4.75 | 4.75-2.00 | 2.00-0.425 | 0.425 - 0.075 | 0.075 - 0.002 | < 0.002 |

**APPARATUS:**

1. Set of sieves (Fine- or Coarse)

2. Scale or weighing balance to an accuracy of 0.01 g

3. Wire brush

4. Trays and wooden mallet

5. Thermostatically controlled oven

6. Mechanical Sieve Shaker

**PROCEDURE:**

1. Oven dry the given representative soil sample for about 24 hours to remove, if any,

moisture present and convert this to pulvarizable form.

2. Crush the soil lumps if any present and pulverize this soil using wooden mallet. It is

recommended not to use metal hammer for pulverization work because the impact

force may likely break an individual soil particle. From this pound soil take

approximately 500 g of the soil passing 4.75 mm sieve and retained on 0.075 mm

sieve for fine (sand) sieve analysis. When dealing with coarse (gravel) sieve analysis

take about 500 g of the same fraction but retained on 4.75 mm sieve and passing

through 38 mm.

3. Arrange a series of sieves with descending order of their aperture size and stack them

one over the other (refer above figure) consisting of the sieve with the largest aperture

at the top most position and smallest aperture size at the bottom. Pan should be

attached below the bottom most sieve to collect the soil passing through it.

4. Place required amount of oven dried soil on the top sieve, close the lid, and transfer

this stack of sieve set to a mechanical sieve shaker. Shake the soil well for a period of

10 minutes and keep it in undisturbed state for some time so as settle the agitated soil

particles.

5. Remove the stack of sieves from the shaker and record the mass of the material

retained on each sieve.

6. Compute the percentage retained on the each sieve by dividing the mass retained on

each sieve by the original mass of the soil sample taken for the analysis.

1. Compute the percent finer by starting with 100 % and subtracting the percent retained

on each sieve as cumulative procedure.

8. Represent graphically PSD or GSD from the obtained results of percentage finer on

Y–axis and particle (aperture) size on logarithmic scale of X-axis.

9. Obtain the values of D10, D30 and D60 from GSD and compute Cu and Cc values. D

denotes diameter of the particle and subscript refers percentage finer. Thus D10

indicates the diameter of the particle corresponding to 10 percent finer.

**CALCULATIONS:**

From the PSD Curve: Coefficient of uniformity,

**Cu = D60/D10**

Coefficient of curvature,

**Cc =D30^2/D60 \* D10**

The values of Cu and Cc can be employed in classifying the given soil as follows:

For a soil designated to be Well Graded / Uniformly Graded Soil,

If, Cu > 4 for Gravels Cu > 6 for Sands and Cc between 0.5 and 2.0 (or 1 and 3) indicates a well-graded soil Cc < 0.1 indicates a possible gap-graded soil

Both Cu and Cc will be 1 for a single-sized soil

If the above criteria are not met, the soil may be termed as Poorly Graded (P).

For a uniform soil: Cu >2 .



Fig. No.8

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Sieve  No. | Sieve  opening  size, d (mm) | Mass of soil  retained  (gm) | Percentage  retained, | Cumulative  percentage  retained, b | Percent finer  N=100-b |
| **1** | **4.75** | **38.5** | **3.85** | **3.85** | **96.15** |
| **2** | **2.36** | **18** | **1.8** | **5.65** | **94.35** |
| **3** | **1.18** | **5.5** | **1.55** | **7.2** | **92.8** |
| **4** | **600μ** | **10.5** | **1.05** | **8.25** | **91.75** |
| **5** | **300 μ** | **481** | **48.1** | **56.35** | **43.65** |
| **6** | **150 μ** | **319** | **31.9** | **88.25** | **11.75** |
| **7** | **75 μ** | **105** | **10.5** | **98.75** | **1.25** |
| **8** | **Pan** | **10** | **1.0** | **99.75** | **0.25** |

**RESULTS:**

Coefficient of uniformity, Cu= 1.53

Coefficient of curvature, Cc= 13.6

**Soil classification:** silty Clay.

**Experiment No: 4**

**DETERMINATION OF CONSISTENCY LIMITS (LIQUID LIMIT, PLASTIC**

**LIMIT AND SHRINKAGE LIMIT) OF THE SOIL**

**As per IS 2720 (Part V)-1985**

**AIM:** To determine the consistency limits (liquid limit, plastic limit and shrinkage limit)

of the given soil sample.

**THEORY:**

When a fine-grained soil has been remoulded by increasing or decreasing its

water content, its consistency gets changed. Thus, if the water content of a fine-grained

soil is gradually reduced, the soil transforms in to different states from liquid, plastic,

semi-solid and finally achieves a solid state. During this process of transition, its volume

and strength subjected to vary based on addition or reduction of water content. The water

content at these transitions can be used for identification and comparison of different

fine-grained soils. The change of state (from liquid to plastic to solid) does not occur

abruptly. It occurs gradually over a fairly large range of water contents, and for this

reason, we require standard tests to determine these limits. These tests are known as

Atterberg Limits tests and the water contents that correspond to the boundaries between

these states or consistencies are known as the Atterberg Limits (refer below figure).

Liquid limit is the water content at which the soil transforms from plastic state to

liquid state.

**APPARATUS:**

1. Casagrande's liquid limit device

2. Porcelain evaporating dish

3. Distilled water

4. Grooving tool

5. Spatula

6. Scale or weighing machine to an accuracy of 0.001 g

7. Water content cans

8. Oven

9. Mercury dish set

10. Flat Glass plate, and

11. Rod of 3 mm in diameter and 100 mm length

**PART-A: DETERMINATION OF LIQUID LIMIT**

**PROCEDURE:**

1. Take about 200 g of oven-dried soil sample passing through 425 microns IS sieve in a

porcelain evaporating dish and mix it thoroughly by adding desired amount of

distilled water with the help of spatula until the paste becomes consistent and

homogeneous.

3. Apply grease or oil at the junctions of Casagrande’s apparatus for smooth running and

frictionless movement rotation mechanism of brass cup. Adjust the height of brass

cup to give a drop of exactly 10 mm with the aid of calibrated gauge on the hard

rubber base at the point of contact.

4. Place a portion of the prepared paste in the cup, level up to approximately 10 mm

depth with the help spatula at the point that hits the hard rubber base. Using ASTM

special grooving tool made to a particular geometry draw a clean and straight groove

through the soil pat, this divides the soil pat into two symmetric parts.

5. Rotate the handle at a rate of 2 revolutions per second and count the number of blows

until the two portions of the soil pat come in contact at the bottom of the groove over

a distance of 13 mm or 1/3 portion. Record the number of blows. Repeat this process

until at least three constant consecutive readings are observed.

6. Take about 25 g of soil paste near to the vicinity of groove to determine the water

content by oven drying method.

7. Transfer the remaining soil paste in to an evaporating dish. Wipe out cleanly inside

surface of the cup with wet cloth. Ensure that no soil paste attached to the surface of

the cup that may greatly influence the energy required, hence blow count, to join two

soil pats.

8. Add either water or dry soil mass depending on obtained preceding number of blows.

Mix thoroughly until a homogenous consistency paste is obtained.

9. Repeat the steps 4 to 7. Obtain at least two readings below 25 numbers of blows and

two readings above 25 numbers of blows between 10 and 50 numbers of blows.

**PART-B: DETERMINATION OF PLASTIC LIMIT**

**PROCEDURE:**

1. Take about 20 g of air-dried sample passing through 425 micron IS sieve.

2. Mix the soil thoroughly with distilled water on the glass plate until it is plastic enough

to be rolled into a small ball.

3. Take about 10 g of the plastic soil mass and roll it into soil threads of 3 mm diameter

between the palm and glass plate. If the diameter of thread becomes less than 3 mm

without cracks, indicating that the water added is more than its plastic limit; hence the

soil needs further kneading between your thumb and fore finger. If soil is too wet, add

small amount of dry soil followed by kneading and roll the soil into threads of 3 mm

diameter again.

4. Repeat the process of rolling and kneading of remoulded soil until soil threads of 3

mm diameter starts showing sings of crumbling during the process.

5. If crumbling starts before 3 mm diameter thread, it shows that water added is less than

the plastic limit of the soil, hence some more water should be added and mixed to a

uniform mass and roll again until the thread starts crumbling at a diameter of 3 mm.

6. Collect the pieces of crumbled soil thread of approximately 10 to 15 g in an airtight

container and determine the moisture content by oven dry method.

7. Repeat the procedure on at least two to three soil samples individually and take the

average value as a representative value of plastic limit.

**Data Sheet for Determination of Liquid Limit and Plastic Limit:-**

**LIQUID LIMIT :**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **S.NO** | **NO OF BLOWS** | **EMPTY WEIGHT**  **(W1)** | **WEIGHT OF WET SOIL**  **(W2)** | **WEIGHT OF DRY SOIL(W3)** | **WATER CONTENT**  **(%)** |
| **1** | 60 | 26 | 49 | 42.02 | 43.57 |
| **2** | 24 | 29.45 | 47.5 | 41.95 | 44.40 |
| **3** | 19 | 27.36 | 52.07 | 44.32 | 45.60 |

Mass of soil =300 grams

Passing sieve =425-micron sieve

Liquid limit is determined by water w =

=45%

**PLASTIC LIMIT:**

Empty weight of Container (w1) =22.48g

Weight of container and wet soil(w2) =24.26g

Weight of dry soil (w3) =23.86g

Water content =

= \*100

=22.6 %

**ENGINEERING PROPERTIES RESULT TABLE :**

|  |  |  |
| --- | --- | --- |
| **S.NO** | **EXPERIMENT NAME** | **RESULT** |
|  | CONSTANT HEAD METHOD | **0.0115 kg/cm^2** |
| **2.** | UNCONFINED COMPRESSIVE STRENGTH | **131 KN/M2** |
| **3.** | STANDARD PROCTOR TEST   1. MDD(Maximum Dry Density) 2. OMC(Optimum Moisture Content) | **23.23 g/cc**  **13.5%** |
| **4.** | SWELLING CHARECTERISTICS | **86%** |

**Experiment No: 5**

**STANDARD PROCTOR COMPACTION TEST (I. S. LIGHT COMPACTION)**

**As per IS 2720 (Part VII)-1980**

**AIM:** To determine maximum dry density and optimum water content of the soil sample.

**THEORY:**

Almost every civil engineering application that uses soil as a construction

material needs compaction. Compaction is a process by which the soil particles will b

artificially rearranged and packed together into a denser state by expelling air content

from the soil matrix. As accomplishment of expulsion of air from soil mass is

relativelyquick process, application of mechanical energy with simultaneous addition

of water issuitable to serve this purpose. The results of this testing are utilized to

establish arelationship between maximum density and optimum water of the soil,

which defines thecompaction work that will be required on a project. The knowledge

of maximum drydensity enables to improve the in-situ ground conditions which

otherwise may beunsuitable for construction. This value also ensures maximum

density (number of soilparticles) accommodated at the most optimum moisture level

to ensure enhanced strength.Optimum water content may be defined as the water

content at which a particular soilattains a maximum dry density for a specific amount

of compaction energy.

**APPARATUS:**

1. Standard Proctor mould of capacity 1000 cc with base plate and collar

2. Proctor hammer weighing 2.7 kg and having a drop of 300 mm

3. Steel straight edge

4. Scale or weighing machine

5. Sample extruder

6. 20 mm and 4.75 mm IS sieves

1. Oven
2. Containers

**PROCEDURE:**

1. Measure internal diameter and height of the compaction mould (refer below figure)

and calculate its volume. Record empty mass of the compaction mould without base

plate and collar.

1. Apply a thin coat of oil to the inside portion of mould and collar as well. Station
2. the compaction mould on the base plate and insert the collar on top of it with in the

grooves provided for this purpose. Secure firmly this assembly to the base plate with

the help of two vertical tie rods and nuts.

3. Take about 3000 gm of oven-dried soil passing through 4.75 mm in a wide mouthed

tray and mix thoroughly in its dry state.

4. As this soil does not contain hygroscopic moisture, start the test witHaddition of 4 %

of water content. Compute the volume of water required equal to the 4 % ofmass of

whole soil taken. Add this water to the soil mass and mix it thoroughly in a wide tray

until homogenous wet soil has been observed. Prefer to use trowel for effective

mixing. Divide the entire soil into three equal proportions.

5. Compact the soil in three equal layers with in the compaction mould (refer below

figure) by imparting 25 number of blows in each layer using Proctor hammer ofmass

2.7 kg with a free fall of 310 mm. Evenly distribute the blows count over the entire

area in each layer. Scratch the top even surface of soil after completion of each layer

with the help of knife or sharp object for enhancing inter-locking of particles between

layers.

6. Carefully remove the collar without disturbing the soil state and trim off the soil flush

with straight edge at the top of the mould.

7. Clean the flush out soil outside of the mould and detach it from the base plate. Record

the mass of wet soil with mould.

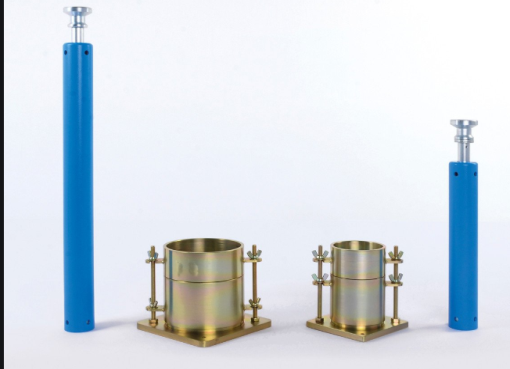
8. Take a representative samples for water content determination from top, middle and

bottom portions of the mould for accuracy of results.

13. Repeat the above procedure corresponding to different water contents until at least

three records of mass of wet soil decreases with increase in water content.

**Figure:** Details of compaction mould and Proctor hammer



**Fig.No. 5**

**CALCULATIONS:**

The bulk density of the soil can be calculated as follows:

In-situ bulk density (kN/m3),γ

***b* =***M****V***In-situ dry density, kN/m**3**, *d* =**1 + *w* γ** γVoid ratio, *e* =***G***γ

***w*γ*d***1− Degree of saturation,***S****r*= *Gw****e***Dry density for ZAV line at S**r=1, γ*****d***= y

*G* + γ*wGw*Where M = Mass of wet soil extracted from core cutter

V= volume of the core cutter used for testing

w = water content of the soil in decimals

G=specific gravity of soil solids

γ**w=unit weight of water**

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**Data Sheet for Compaction test by Proctor Method:-**

Diameter of the mold, D Height of the mold, H Volume of the mold, V Mass of empty mould +base plate, (M1)

SI No.

Mass of mold+baseplate+compacted soil (kg)

Bulk density, γ=M/V (kN/m3) Mass of compacted soil, M=M2-M1

Water content , w (%)

Dry density, w) γ**d=γ/(1+** kN/m**3**

Dry density at S**r=1**γ**d=G.γw/(1**+w.G) kN/m**3**

**RESULTS:**

Maximum dry density, MDD (kN/m3) = 1.832

Optimum moisture content, OMC (%) = 13.5%

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| S.NO | WATER CONTENT  (ML) | WEIGHT OF MOULD  (kg) | WEIGHT OF SOIL  (kg) | EMPTY CAN WEIGTH  (kg) | WEIGHT OF WET SOIL  (kg) | WEIGHT OF DRY SOIL  (kg) | WATER CONTENT  (%) | DRY DENSITY  (g/cc) |
| 1 | 120 | 2.045 | 3.75 | 0.054 | 0.095 | 0.092 | 7.8 | 1.58 |
| 2 | 140 | 2.045 | 3.867 | 0.021 | 0.055 | 0.052 | 9.6 | 1.66 |
| 3 | 160 | 2.045 | 4.021 | 0.022 | 0.054 | 0.051 | 10.3 | 1.79 |
| 4 | 180 | 2.045 | 4.056 | 0.022 | 0.068 | 0.061 | 17.9 | 1.70 |
| 5 | 200 | 2.045 | 3.980 | 0.021 | 0.064 | 0.056 | 22.8 | 1.57 |

**Fig. No. 6**

**EXPERIMENT:6**

**UNCONFINED COMPRESSIVE STRENGTH**

**Unconfined Compression Test (UCT):**

**AIM:** It is a simple laboratory testing method to assess the mechanical properties of rocks and fine-grained soils. It provides a measures of the undrained strength and the stress-strain characteristics of the rock or soil

**APPARATUS:**

Compression machine, proving ring, deformation, dial gauge, trimmer, sampling tube, specimen extruder, split mould, specimen trimming tools.

**PROCEDURE:**

1. Prepare the test specimen, which may be either undisturbed remoulded (or) compacted .
2. Place the specimen on the bottom plate of the compression machine and adjust the upper plate to contact the specimen. initialization the vertical displacement gauge and proving ring gauge to zero. Select an axial strain rate between 0.5%to2.0% per minute and apply compression load .
3. Record the load and displacement readings at every 20 to 50 divisions of displacement gauge ,or every 15 seconds.
4. Compress the specimen till the loads peaks and then falls ,or till the vertical deformation reaches 20% of the specimen length.
5. Remove the specimen from the machine and takes soils samples from water content determination.



**UCC CALCULATION TABLE :**

Least count deformation dial gauge =0.01

Proving ring constant = 0.228

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| S.NO | VERTICAL DIAL GAUGE | STRAIN (E) % | COMPACTED AREA | PROVING RING | LOAD  PRRXPRCX5 | UNCONFINE COMPRESSIVE STRENGTH | UNDRAINED SHEAR STRENGTH |
| 1 | 50 | 0.5 | 9.669 | 3.6 | 4.104 | 0.424 | 0.212 |
| 2 | 100 | 1 | 9.718 | 5 | 5.7 | 0.286 | 0.2.93 |
| 3 | 150 | 1.5 | 9.76 | 8 | 9.12 | 0.934 | 0.467 |
| 4 | 200 | 2 | 9.81 | 8.2 | 9.348 | 0.962 | 0.476 |
| 5 | 250 | 2.5 | 9.36 | 8.2 | 10.46 | 9.948 | 0.474 |
| 6 | 300 | 3 | 9.91 | 9.1 | 11.62 | 1.046 | 0.532 |
| 7 | 350 | 3.5 | 9.96 | 10.2 | 12.54 | 1.16 | 0.58 |
| 8 | 400 | 4 | 10.02 | 11 | 12.54 | 1.24 | 0.62 |
| 9 | 450 | 4.5 | 10.07 | 11 | 12.54 | 1.245 | 0.62 |
| 10 | 500 | 5 | 10.12 | 11 | 12.54 | 1.39 | 0.619 |
| 11 | 550 | 5.5 | 10.18 | 11 | 12.54 | 1.233 | 0.616 |
| 12 | 600 | 6 | 10.23 | 11 | 12.54 | 1.22 | 0.613 |

**RESULTS TABLE AFTER ADDING ADMIXTURES :**

|  |  |  |
| --- | --- | --- |
| **S.NO** | **EXPERIMENT NAME** | **RESULT** |
| **1.** | CONSTANTHEAD METHOD | **1.12\*10^-2 kg/cm^2** |
| **2.** | UNCONFINED COMPRESSIVE STRENGTH | **34.2** |
| **3.** | STANDARD PROCTOR TEST   1. MDD(Maximum Dry Density) 2. OMC(Optimum Moisture   Content) | * 1. **gm/cc**   **14%** |
| **4.** | SWELLING CHARECTERISTICS | **40%** |

**Free Swell Index:**

|  |  |
| --- | --- |
| % Replacement | % Swell |
| 0 | 89 |
| 2 | 86 |
| 4 | 79 |
| 6 | 66 |
| 8 | 55 |
| 10 | 25 |

The graph shows the change in volume of soil in different proportions of Rice Husk Ash

**CHAPTER V**

**CONCLUSION:**

Overall it can be concluded that the Quarry dust and Lime mixture can be considered to be good in ground improvement technique specially in engineering project on weak soils like black cotton soil (BC) soil and red soils when they act as substitute to deep and raft foundations, reducing cost as well as energy.

* Specific gravity of BC soil decreased with the addition of quarry dust and lime, this reduction of specific gravity value may be due to the reduction of plasticity character of BC soil.
* Maximum dry density (MDD) is observed at soil for addition of quarry dust and lime. Further addition of it, MDD value decreased.
* The strength of black cotton soil increasing with the addition up to soil and further decreased.
* From the test it is concluded that the strength characteristics of BC soil are optimum at (8% lime + 20% quarry dust) .

**CHAPTER 6**

**REFERENCES**

1. Mishra B. A study on engineering behavior of black cotton soil and its stabilization by use of lime. International Journal of Science and Research. 2015 Nov; 4(11): 1–5.

2.Tiwari A, Mahiyar H K. Experimental study on stabilization of black cotton soil by fly ash, coconut coir fiber and crushed glass. International Journal of Engineering Technology and Advanced Engineering. 2015 Nov; 4(11): 1–4.

3. Ghosh P. Fibre Science and Technology. First Edition. Tata McGraw Hill Publishing Company: New Delhi; 2004.

4. Olufowobi J, Ogundoju A, Michael B, Adrinlewo O. Clay soil stabilization using powdered glass. Journal of Engineering Science and Technology. 2014 Oct; 9(05): 541–58.

5. Suresh K, Padmavathi V, Sultana A. Experimental study on stabilization of black cotton soil with stone dust and fibers. Proceedings of 48th Indian Geotechnical Conference; India; 2009. p. 1–5.

6. Sarkar R. Geotechnical characterization and utilization of pond ash-an Industrial waste. Keynote Speech.International Brain Storming Workshop on Solid Waste Management; 2013.

7. Ismail K N, Hussain K, Idris S M. Physical, Chemical and mineralogical properties of fly ash. Journal of Nuclear and Related Technology.2007 Jul; 4: 47–51.

8. Sarkar R, Abbas S M, Shahu J T. A comparative study of geotechnical behaviour lime stabilized pond ash from Delhi region. International Journal of GEOMATE. 2012 Sep; 3(01): 273–279.

9. Patil B M, Patil K A. Improvement in properties of subgrade soil by using moorum and RBI grade 81. International Journal of Scientific and Engineering Research. 2013 May; 4(05): 1–4.

10.ShuklaDevadatt, RajanShikhaSaxena A.K, Jha A.K (2015) “Soil Stabilization Using Coconut Coif Fibre” Internaional Journal for Research in Applied Science & Engineering Technology (IJRASET), Vol:3 Issue No:9, 305-309.

11. [2] PriyankGoyal, AshutoshShankerTrivedi, ManojSharma(2015) “Improvement in Properties of Black Cotton Soil with an Addition of Natural Fibre (Coir) Derived from Coconut Covering” International Journal of Engineering Research and Applications (IJERA), Vol:5 Issue No:3, 36-37.