

AN REPORT ON SUBGRADE PAVEMENT CONSTRUCTION WITH STABILIZED BLACK COTTON SOIL

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Abstract: The design of subgrade pavement construction with black cotton soil [expansive soil] has always been difficult for the engineers as the structure resting on black cotton soil cracks without any warning. Black cotton soil is available in M.P, Karnataka, Maharashtra, and Andhra Pradesh in our country. Soil proportion changes depending upon their constituents, i.e. water content, density, bulk density, angle of friction, shear strength, etc. The properties of black cotton soil can be modified by stabilization with cement and sand. The present work is done by stabilizing the black cotton soil by using cement and sand. The tests conducted for this work were Atterberg limits, specific gravity, standard proctor test, and unconfined compression test, California bearing ratio, liquid limit, plastic limit, and shrinkage limit. By conducting all these tests graphs and charts and tables can be drawn.

Keywords: Unified soil classification system (USCS), CBR and Ordinary Portland cement (OPC).

1.1.GENERAL

Soil is formed by the physical (or chemical) disintegration of rocks, as well as air, water, organic matter, and other substances. Soil is a porous, non-homogeneous soil earthy material whose engineering behavior is influenced by changes in temperature. Density and moisture content Soil can be divided into four categories based on its origin. There are two types of organic and inorganic materials: organic and inorganic.

Organic soils contain a mix of nutrients derived from plant development and decomposition. Plantlife, as well as the formation of a microscopic organism's skeleton or shell Soils that are not organic. Soil is devoid of organic matter. Residual soil is dirt that is still there where it was created. If the soil is in good condition, the term "residual soil" refers

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to a soil that is still present where it was produced. If the soil is fertile, It is referred to as has been moved to another location by gravity, water, or wind. soil that has been hauled Soil can either stay in its original location or be transferred by numerous natural organizations.

In the previous instance, it was described as 'residual,' and in the latter, 'transported' is used. Aggregates are formed by the clumping of soil textural components such as sand, silt, and clay, and the subsequent combination of those aggregates into bigger units. Soil the peds is a type of construction. India's most important deposits.

The soil deposits of India can be divided into the following categories: Peaty and marshy soils, Laterite soils, Alluvial soils, Desert soils, Saline and Alkaline soils, Red soils, Laterite soils, Alluvial soils, Desert soils, Saline and Alkaline soils with black cotton. Because of its swelling and shrinking characteristics, costly soil is always a challenge for engineering buildings. In the summer, it shrinks when dried, and in the winter, it swells when wet. Large-scale destruction occurs to structures built on these soils.

As a result of the pricey soil's property, it breaks without notice. These fissures can be rather extensive at times, and they cause significant structural damage. Roads that run through expensive soil regions suffer from extreme distress, resulting in poor performance and higher maintenance costs. Clayey soils with a plasticity index of more than 6 must alsobe treated and stabilized before being utilized for construction, according to the Ministry of Road Transport and Highways of India's specifications. Stabilization of soil by stabilizing elements such as fly ash, lime, sand, bitumen, cement, rice husk ash, and others is essential to prevent such damage to the structure. These stabilizing chemicals can greatly improve the engineering qualities of black cotton soil. The use of sand and cement to stabilize soil has been practiced for a long time. Mixing Portland cement, sand, and powdered black cotton soil with the right amount of moisture and compact the mixture to get the right density. Cement sand soil is a substance made by combining soil, cement, and sand. Cement in the range of 2 to 5% improves the engineering qualities of B.C. soil significantly.

Increasing the quantity of sand in the soil as a stabilizer also improves its characteristics. When water is added to the mix and compacted, soil-sand-cement is formed; the small proportion of cement is unable to bind all of the particles to a coherent mass, but it interacts with the silt and clay fractions, reducing their affinity for water and reducing the swelling behavior of the mix, which modifies the properties of soil and increases its strength. Controlled compaction, proportioning, and/or the addition of suitable admixtures or stabilizers improve the strength or bearing capacity of the soil. Soil is a naturally occurring substance that is stabilized to improve strength and durability under design use conditions and extend the engineering project's design life.

Soil qualities vary depending on its location, physical properties, and other factors. Various ways for soil stabilization are available, and each method should be tested in the laboratory first with soil material before being used in the field. The basic quality of the soil should be good strength and load-bearing capability so that external loads may be properly transferred to the lower layers without structural failure. necessary to improve the soil's intended qualities Long-term physical and chemical changes in the soil will improve their physical properties, improving shear and unconfined compressive strength and permanently lowering the soil's permeability to water. The main principles of soil stabilization are to

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evaluate soil properties, determine missing soil qualities, choose an appropriate stabilization method, and design a stabilized soil mix sample.

The soil's gradation is also a significant attribute to consider, as the soil can be well-graded, which is preferable because it has fewer voids, or evenly graded, which appears stable buthas more voids, so it is preferable to grade the soil properly. Because it is exceedingly expensive to replace the inferior soil during construction, different types of soils are mixed to increase the soil strength properties. Soil Cement Stabilization is a dense mixture of soil, cement, and water compacted to build a strong base course and boost the soil layer's compressive strength. All varieties of Pavements can benefit from the use of soil-cement as a sub-base or base course. Lime Stabilization of the Soil Soil-lime has long been employed as a modifier or binder for high-plastic soils, imparting binding action even to granular soils. Bituminous Stabilization of the Soil It is possible to utilize a bitumen-stabilized layer. The essential concepts of this stabilization are Water Proofing and Binding of soil components, which strengthens its strength, and the most usually utilized materials are cut back and emulsion. Stabilization of lime fly ash Embankments and rigid and semi-rigid pavements can all be built with this material. Fly ash has a wide range of qualities that must be defined before it can be utilized to stabilize soil layers. The principal elements of fly ash include silica, aluminum, iron, calcium, and magnesium oxides, which have numerous beneficial features for embankment and road construction. Fly ash is also referred to as an environmentally friendly resource that improves soil condition

DEFINITION OF BLACK COTTON SOIL

The soil in black cotton is exceedingly compressible and has a limited bearing capacity. The soils exhibit significant shrinkage and swelling. This soil's shear strength is extremely low. Expansive soil is another name for black cotton soil. The broad soil deposits are known in Indian lore as "black cotton soil." Black cotton soils cover a considerable section of central and southern India, including Madhya Pradesh, Maharashtra, Karnataka, Tamil Nadu, South Gujarat, and Uttar Pradesh.

ADVANTAGES OF BLACK COTTON SOILS

The following are some of the benefits of black cotton soil: • Because BLACK COTTON SOIL is generally fertile, it is ideal for agriculture

• Their iron-rich granular structure makes them resistant to wind moisture. • The crack generated by black cotton soil can be used as a rainfall conduit, and it has a high bearing capacity in arid conditions .

DISADVANTAGES OF BLACK COTTON SOILS

• When black cotton soil obtains wet, it loses its bearing capacity and is particularly difficult to handle due to its swelling and drying character. • The building constructed on this soil is unsafe because the volume expands from 20% to 30% of its original volume, causing foundation cracks. • Increased stabilisation should be performed for every construction that has distinct features.

1.2. OBJECTIVE

In this research, our main objective is to study the black cotton soil and its properties and used Stabilization is essential in the construction industry to improve its features. To increase the qualities of black cotton soil, we add sand and cement during stabilisation. • Sand and cement are utilised as stabilising materials in standard and customised proctor tests to improve the optimum moisture content. • To investigate the effect of cement and sand in the stabilisation of black cotton soil, which is more prevalent in some combinations. • To determine the best combination for stabilising black cotton soil. • To figure out what percentage of agricultural waste can be used in the stabilisation process.

LITERATURE REVIEW

This research aims to make black cotton soil as a construction material and improve its properties by using sand and cement black cotton does not have sufficient properties to use in construction is used only in cultivation in that way it can be used in subgrade Pavement construction. In subgrade of pavement sand and gravel have the best properties so that's for we add soil for stabilization of black cotton soil than it improves the strength and moisture content and other properties. Mrs. Neetu B. Ramteke, Prof.AnilkumarSaxena, and Prof. T.R. Arora (2014) The stabilisation of black cotton soil using sand and cement as a pavement subgrade, and found that cement stabilisation is rather independent of soil parameters. The soil's strength and compressibility qualities are being improved. After that, the earth is stabilised using sand and cement. The amount of sand for stability was calculated as 10%, 20%, 30%, and 40% by dry weight of soil, respectively, and the amount of cement was calculated as 2% by dry weight of soil. Mixed samples were created as follows using these proportions, and a series of laboratory tests were conducted to evaluate the index characteristics and CBR values of both natural soil and mixed proportion samples. The soil is classified using a sieve analysis test. According to the AASHTO Classification Chart, it belongs to the A-7 group and the A- 7-5 subgroup. The soil is classed as MH by the Unified soil classification system (USCS) and the IS Classification system (Silt of High Compressibility). The Atterberg limits are a basic metric for fine-grained soil type. Depending on the amount of water present Sold, Semisolid, Plastic, and Liquid are the four states in which soil can be found. The consistency and behaviour of the soil in each state differs, as do its engineering properties. As a result, a change in the behaviour of the soil can be used to identify the boundary between each condition. Compaction tests are performed in the laboratory on soil samples to determine the amount of compaction and water content necessary in the field. The study shows that when the sand concentration increases, the CBR value rises until it achieves a desired CBR value for subgrade pavement. In most cases, the soaking CBR value is used in pavement design. The addition of sand to the soil improves the wet CBR value from 1.93 percent to 7.39 percent, according texperiments. When employing 40% sand and 2% cement, the highest CBR is achieved. 343 editor@iaeme.com Stabilization of Black Cotton Soil with Sand and Cement as a Subgrade Pavement http://www.iaeme.com/IJCIET/index.asp Douglas O.A. Osula, Senior Lecturer, Department of Civil Engineering, Auchi Polytechnic, Bendel State, Nigeria, conducted a study on the Evaluation of Laterite Soil Stabilization. To stabilise the problematic clay, Portland cement and hydrated lime were used as stabilisers and admixtures in this investigation. The findings revealed that as time passes, strength gains become more apparent. Furthermore, the spectrum of combinations examined has shown to have a good level of durability. As a result,

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the evaluation criterion for this should be unconfined compressive strength and California bearing ratio values. form of stabilization for problem laterite. This high value of UCS compared with the conventional value of 1.08 N/mm2 for lime stabilization is justified by the superior pozzolanic nature of the cementitious reaction in this admixture stabilization Expansive soils are found in India in locations with annual rainfall ranging from 300 to 900mm. The Montmorillonite concentration is the main clay fraction in these soils, according to Subbarao et al. The CEC (Cation Exchange Commission) is a non-profit organisation that promotes the exchange These soils' capacity ranges from 80 to 130 m.eq/100 gm, and their uniformity is limited. Liquid limit, plastic limit, and weight restriction range from 53 percent to 100 percent, 20 percent to 50 percent, and 7 percent to 18 percent, respectively. correspondingly, a shrinkage limit For black, the specific gravity ranges from 2.7 to 2.9. Cotton-growing soils Black cotton soils have a high silica content (60%) in the clay fraction. Only 15% iron and 15% alumina are present. During the monsoon, these soils, particularly those near the river, become saturated.

2. MATERIALS

BLACK COTTON SOIL:

A black cotton soil sample was submitted from Shankarpurheti, Tehsil Chambishi, District Gachibowli, Maharashtra, India. The dirt was air-dried and crushed before being ovendried at 1100C to pass through an IS 425-micron filter. Expansive soils are known as Black Cotton soil in India. The term "Black Cotton Soil" comes from the agricultural world. The majority of these soils are black in colour and are ideal for producing cotton. They can be found in a variety of locations. Maharashtra, Gujarat, Madhya Pradesh, Karnataka, Andhra Pradesh, and Tamil Nadu are the states that make up Maharashtra. These are wideranging. These soils are challenging to deal with in foundation design because of their high swelling and shrinkage potential. All expansive soils are not black soils, and all black soils are not expansive soils. These soils have a high strength in the summer and a rapid drop in the winter. Because of the presence of montmorillonite minerals, the soil has a swelling property. Black cotton soils offer a lot of room to expand. These soils have a high optimal moisture content and a low shrinkage limit. It is quite sensitive to changes in humidity.

Figure. 1CHEMICAL COMPOSITION

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Table 1:CHEMICAL COMPOSITION OF BLACK COTTON SOIL

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

3 METHODOLOGY AND TESTS

3.1.Specific Gravity

Specific Gravity is defined as the ratio of the mass of any material with an unambiguous volume partitioned by the mass of an equivalent volume of water. It is the number of times the soil solids are heavier in comparison to the equal volume of water contained in soils. So it's essentially the number of times dirt weighs more than water. The specific gravities for different types of soils are not the same. During the inquiry period, temperature correction should be considered, and water should be free of gas refined water. The letter 'G' stands for the specific gravity of the soil. Particular gravity is a powerful force.The void percentage, thickness, porosity, and immersion condition are all physical parameters that are utilised to calculate other soil design properties. Specific Gravity is defined as the ratio of the weight of soil solids to the weight of an equivalent volume of water. The calculation is carried out in a volumetric jar in a test setting, where the volume of the soil is calculated and the weight of an equivalent volume of water is then subtracted. The particular gravity is represented by the letter G.

$$(M2 – M1) – ((M4 - M1) – (M3 – M2)$$

M1 is the bottle's weight. M2 = Bottle weight + dry soil weight M3 = Bottle weight, dry soil weight, and water weight. M4 = Bottle and water's combined weight Although specific gravities for different soils vary, the following categories can be used to classify the overall range of specific gravities.

Table 2: Standard Specific Gravity

TYPES OF SOIL	**SPECIFIC GRAVITY**
Sand	2.63-2.67
silt	2.65-2.70
Clay and silty soil	2.70-2.90
Organic soil	1.00-2.67

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Soil particles are made up of a diverse range of sizes and forms. Molecule sizes range from a few microns to a few penny metres in the same soil test. The size and state of particles contained in the soil samples are used to determine a variety of physical attributes of the dirt, such as its quality, porousness, thickness, and so on The two methods for determining particle size appropriation are sifter examination, which is used only for coarse-grained soils, and sedimentation investigation, which is used for finegrained soil tests. Both are plotted on a semi-log diagram, with the ordinate representing the rate better and the abscissa representing the molecule distance across, i.e. sifter sizes on the left i.e. logarithmic sifter sizes The coarse-grained soil strainer inquiry has been focused. The types of soil found are generally those that have been over- or under-evaluated. Different particles of various sizes and shapes are found in a fair amount in all of the soils examined. The soil, on the other hand, is said to be ineffectively or consistently evaluated if it has particles of a few sizes in overabundance and inadequacy of particles of varied sizes.

3.2. ATTERBERG LIMITS

The moistness substance or current dampness, given in rate of mass of oven-dried soil at the breaking point constructed between the fluid and plastic states, is the fluid farthest reaches of a dirt. The water content at this farthest point condition is securely identified as far as possible and is the clamminess content at consistency as managed by technique for the standard fluid maximum mechanical get together.The moisture material is compared to the fluid-plastic limit of the soil mass as much as possible. When jostled 25 times using the usual measurement for a length of 12mm of a notch at the fluid breaking point, the dirt has such a low shear quality (17.6g/cc).As far as possible is the dampness content at which the dirt stays in the plastic state. It is the water content at which the dirt just starts to disintegrate when moved into a string of 3mm breadth. the most common fluid gadget or device One of the mechanical assemblies used for determining the fluid farthest reaches of a soil substance is the Casagrande contraption. As far as feasible refers to the amount of water in the glass that causes 25 droplets of water to form an abnormally close furrow. SCOPE 4.1 This section explains how to determine the plastic limit of a substance in the lab. soils. For averaging, two trials' results must be acquired. This approach is based on AASHTODesignation T90, which has been tweaked for use in New York. Use by the Department of Transportation. 4.1 A soil's plastic limit is its moisture content expressed as a percentage of its total volume. at the transition between the plastic and semisolid stages, the weight of oven-dry earth of reliability It's the moisture content at which a soil starts to collapse. when coiled into an 18 in. (3 mm) diameter thread with a ground glass plate any other suitable surface Plasticity Index (P.I.) = Liquid Limit (L.L.) – Plastic Limit (P.L.)

Figure 2.:- Liquid limit apparatus

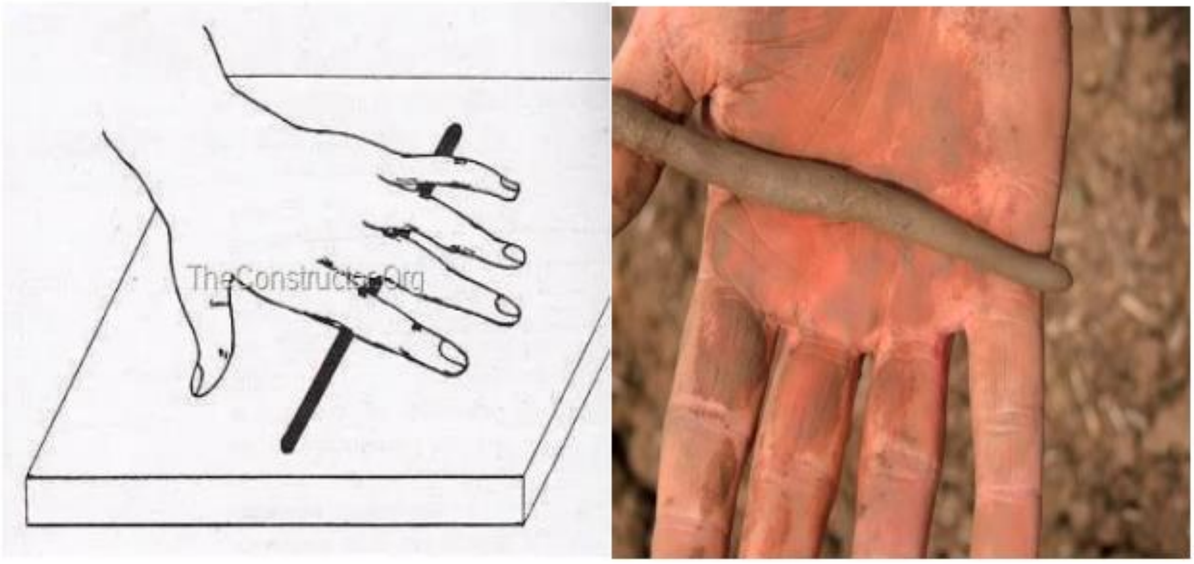

Figure 3 plastic limit apparatus

Material left over from the completely mixed section of the soil produced for the liquid limit test, which is generally at a moisture content greater than the plastic limit, can be used for the test. Allow for air drying of the sample until the liquid limit test is finished. If the sample is too dry to roll to an 18 in. (3 mm) thread, add water, fully mix, and season in the air before doing the test. 4.2 If no remaining soil from the liquid limit test is available and the soil is granular or contains sand sizes, it must be prepared as described under Liquid Limit (4.3 and 4.4). When no leftover soil from the liquid limit test is available and it is determined that the soil is organic or fine-grained with no more than No. 40 (0.425 mm) material, the plastic limits shall be determined on natural soil that has been brought to the approximate moisture content for plastic limit determinations. 4.2.3 Shrinkage limit • Take a 100 gm soil sample from a thoroughly mixed piece of material that has passed through a 425 m Sieve. Mix 30 grammes of the above soil sample with distilled water in an evaporating dish to get a creamy slurry. (Use a water content slightly higher than the liquid limit.

Spread a thin layer of Vaseline inside the shrinking dish to keep the dirt from sticking to it. • Layer the wet dirt in the dish in three layers using a spatula. Tap the dish gently on a firm surface until the dirt spills over the sides and no obvious breaks appear. • Use a scale to measure the weight of the dish moisten the soil as soon as possible, and make a tally of the weight. • Allow the wet dirt cake to air dry for 6 to 8 hours, or until the colour of the pat changes from dark to light. After that, the cake should be dried in a 1050°C oven. • At 1100°C for 12–16 hours • Remove the dried dirt disc from the oven and place it on a cooling rack. Cool it down in a desiccator Calculate the dish's weight using a dry sample. • Calculate the empty dish's weight. • Find the volume of the shrinkage dish, which is the same as the volume of wet soil: • Fill an evaporating dish halfway with mercury from the shrinkage dish. The button has been pressed. • Remove a dry soil pat from the shrinkage dish and place it in a glass cup filled with water to calculate its volume. • mercury is used in the process described here to fill the glass cup with mercury till it overflows into a larger one. • Mercury that has accumulated in the environment should be eliminated. • Cover the cup with a glass plate with prongs and press it. Make sure there are no air bubbles trapped. Wipe down the outside of the house to remove the mercury that had become encrusted on the glass cup Place it in a larger, clean, and empty dish after that. • Cover the mercury with a dry dirt pat. Using the floating pat, submerge it in the water glass plate, which is floating as well

3.3 Compaction Test

Figure 4 Standard proctor test

The compacted soil The purpose of this test is to determine the relationship between the wetness material and the dry thickness of soils compacted in a mould of a specific size using a 2.5 kg rammer dropped from a height of 30 cm. It is a framework for determining the optimal dampness content (OMC) at which a specific soil will become most thick and finish with the maximum dry thickness (Yd). The name Proctor was given to him by his father. In 1933, R. R. Delegate demonstrated that the dry thickness of soil for a comp dynamic effort is determined by the amount of water the dirt holds throughout soil compaction. His exceptional test is frequently misconstrued as the usual Proctor compaction test, which was recently reintroduced. updated to making a new test for compaction. The Modified Proctor Test is what it's called. If the delegate is changed, all of the methods remain the same with a few minor changes. The compaction burden is larger in this area in particular. Rammer's weight was reported to be 4.5 kg, and he was only 18 inches tall. The majority of these lab examinations entail compacting soil at a perceived moisture content into a barrel-shapedmould with prescribed estimations. The soil is usually compressed into the mould in a particular number of similar layers, each of which is given a number of hits from a standard weighted hammer of a standard stature. The dry densities for each case are resolved after this technique is repeated for unmistakable properties of substance. Materials are filled in five equal layers for this condition, each with 25 blows. The mallet and mould used in the modified delegate test are shown below. The dry thickness to dampness material graphical

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association is next drawn using the attributes discovered to set up the compaction bend. The determined bent fits like a glove and becomes thickness worth is becoming scarce to a most extreme cut off, and then the quality is deteriorating again. Finally, the top purpose of the compaction bend and its corresponding dampness content, known as the optimum dampness content, are used to determine the most extreme dry thickness (OMC). The equations that were used are listed below. (weight of wet soil in mould grammes) / (normal wet density) (volume of mould cc) ((weight of water grammes) / (weight of dry soil grammes)) = moisture content (percentage) a hundred percent Wet density / (1+ (moister content/100)) Equals dry density d (gm/cc)

Figure 5:- Modified proctor apparatus

3.4. California Bearing Ratio Test

CBR is the amount of power necessary for each unit district to enter a dirt mass with a standard burden at a rate of 1.25 mm/min in order to infiltrate a standard material at a rate of 1.25 mm/min. The following table shows the standard burdens for various infiltrations for standard material with a CBR nature of 100%. This standard burden uses limestone as the standard material, and its CBR esteem at 2.5 mm, 5 mm, 7.5 mm, and 10 mm infiltration is used to determine CBR esteem.

Figure 6 CBR test Apparatus

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CBR value is calculated by this formula: C.B.R. = (Test load /Standard load) 100 % Standard load is for particular depth of penetration of plunger is given bellow

Table 3: Standard load in different penetration

Penetration of plunger (mm)	Standard load (kg)
2.5	1370
5.0	2055
7.5	2630
10.0	3180

The CBR test was performed on compacted earth (30 blows) in a tube-shaped CBR mould with a detachable neckline of 50 mm and a distinct perforated base plate of hard metal, with a detachable neckline of 50 mm and a distinct punctured base plate of hard metal. Throughout the images, a displacer plate, 50 mm in diameter, is shown inside the mould, from which a sample of 125 mm in diameter is obtained as true depth. The dry thickness and water content should be maintained throughout the field compaction process. CBR properties of drenched and unsplashed samples are resolved in general. Every extra charge opening weight measuring 2.5 kg and measuring 147 mm in estimation with a central complete 53 mm in separation crosswise over is considered give or take. take the equivalent of 6.5 cm of growth A minimum of two extra charge weights are given and placed on the sample. The infiltration rate is roughly 1.25 mm/min due to the burden. At unmistakable infiltrations of 0, 0.5, 1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 5.5, 6, 6.5, 7, 8, 9, 10, 11, 12, and 12.5 mm, the heap readings are recorded. If an infiltration of less than 13 mm occurs, the greatest weight and entrance is noted. Despite the fact that the starting portion of the bend may be curled upwards due to surface irregularities, the bend is mostly raised upwards. After that, an adjustment is made by attracting a digression to the curve at the most prominent slant. The point where the digression meets the abscissa will be the adjusted inception. The CBR is a group of people who work together to Infiltrations of 2.5 mm and 5 mm are usually assessed for quality. CBR values at 2.5mm entrance are usually brighter than 5mm infiltration, and in this instance, the past is used as the CBR respect for black-top structure configuration reasons, which is why CBR is such an important determinant of black-top thickness.The test is repeated if the CBR worth compared with a 5mm infiltration exceeds that with a2.5mm infiltration. If the results are still uncertain, the bearing proportion identifying with 5mm infiltration is used as a guideline.

3.5.Compressive Strength in Unconstrained Conditions

The shearing resistance of binding soils, whether undisturbed or remoulded, is measured using the unconfined pressure test. The strain-control or anxiety-control conditions are used to connect a hub burden. The largest unit anxiety gained within the first 20% of compression is referred to as the unconfined compressive quality. A round and hollow example of soil is arranged according to IS 4332 section v for rock, i.e. a test with a breadth of 100 mm, to execute an unconfined pressure test. and tallness ofIn the lab, 200 mm using the U.C.S. form. The dirt sample is placed in a stacking casing on a metal plate, and the administrator raises the level of the base plate by turning a wrench. The top plate, which is attached to a balanced

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demonstrating ring, limits the highest point of the dirt specimen. A hub burden is attached to the example as the base plate is elevated. The administrator adjusts the wrench at a set rate to maintain a constant strain rate. To shear the example, the heap is gradually expanded, and readings are taken intermittently of the power connected to the specimen and the subsequent deformity. The stacking proceeds until the dirt builds up a conspicuous shearing plane or the disfigurements get to be extreme. The deliberate The information is used to concentrate on the dirt example's quality and the anxiety strain's characteristics

4. RESULTS AND ANALYSIS

Specific gravity IS: 2720 (part-III, section-1) 1980 was used to determine the specific gravity of the various materials. EAF dust, black cotton soil, and dolime fine had specific gravity values of 3.55, 2.57, and 2.35, respectively. Calculation table 1 for specific gravity test Specific gravity = mass of soil/mass of water displaced by soil SG=(M2-M1)/(M2-M1)-(M3-M4)

DESCRIPTION	1	2	3	4
Weight of density bottle W_1 in gms	22.5	22.5	22.5	22.5
Weight of density bottle+ dry soil W_2 in gms	43.5	44.0	45	43
Weight of density bottle+ soil+ water W_3 in gms	89	88.5	90	89
Weight of density bottle+ water W_4 in gms	77	77	77	77
Temperature of water T in c	29	29	29	29
Specific gravity of soil solids G	2.3	2.15	2.36	2.41

Liquid limit test The liquid limit is determined by placing a clay sample in a standard cup and using a spatula to create a separation (groove). The cup is dropped until the distinction is no longer visible. This sample is used to determine the soil's water content. The test is repeated with the water content increased. Calculation for liquid limit test On a semilogarithmic graph, a flow curve representing water content on an arithmetical scale and the number of drops on a logarithmic scale shall bedisplayed. The flow curve is a straight line drawn as close to the four or more plotted points as possible. The moisture content of 25 drops, as determined by the curve, must be rounded to the nearest whole50 number and reported as the soil's liquid limit. If = (W1-W2)/ log10(N2/N1) and If = Flow Index W1 = Moisture content in percentage for N1 drops; W2 = Moisture content in percentage for N2 drops 5.2.1.

Table 4 content for liquid limit

SL.NO	DESCRIPTION	1	2	3	4	5
1	Container no.	1	2	3	4	5
2	Weight of container	36	36	36	36	36
3	No of blows	20	15	13	10	5
4	Weight of container + wet soil in grams	69	70	65	75	70
5	Weight of container + dry soil in grams	59	59	55.5	65	55
8	Water content	45%	47%	48%	50%	52%

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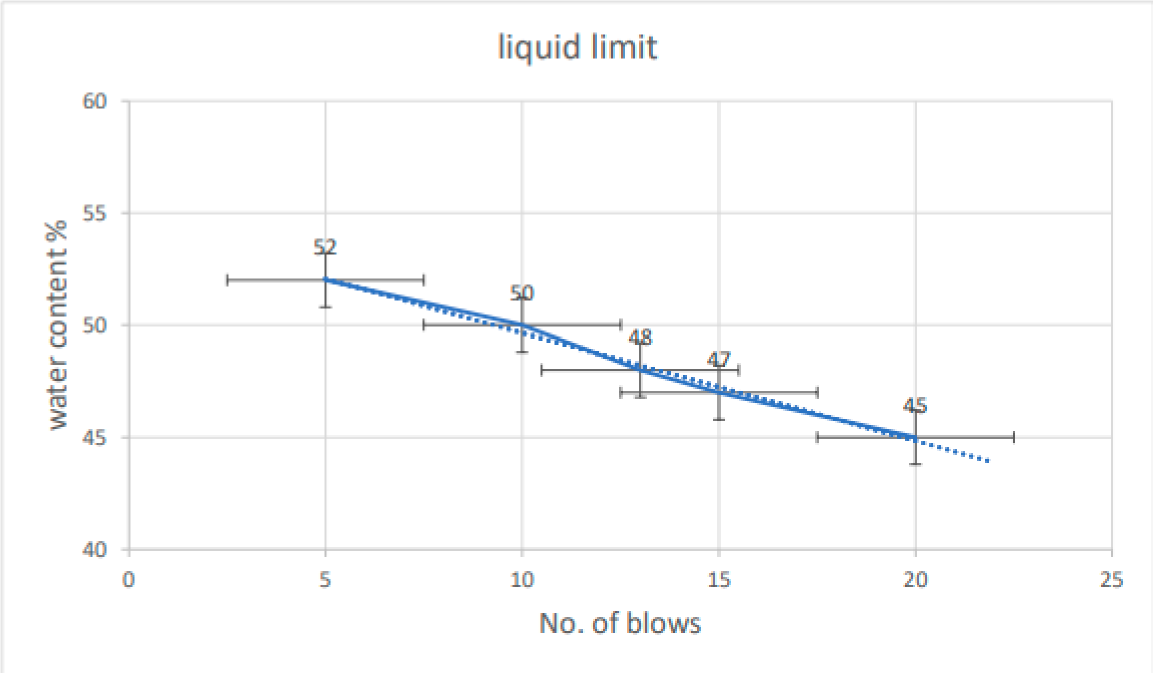
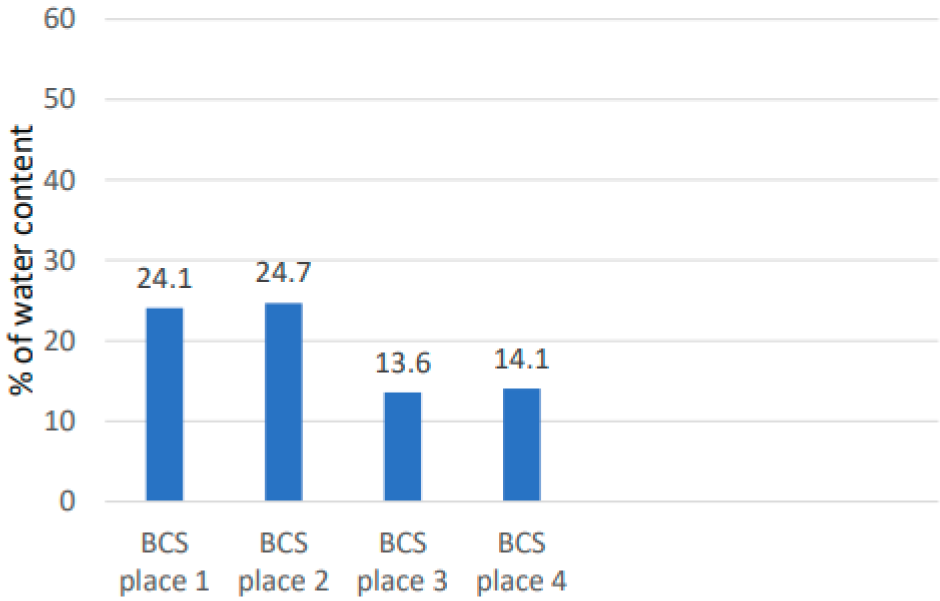
Graph for liquid limit



4.1 Plastic limit test

As a percentage of the weight of the oven-dry soil, calculate the moisture content of each soil sample as follows: Plastic limit = (weight of water/ weight of oven-dry soil)*100



4.2. Standard proctor test

To determine the values of Optimum Moisture Content (OMC) and Maximum Dry Density (MDD) using a graphical relationship of "dry density" to "moisture content" in the form of a "compaction curve" (MDD). IS-2720:1983 (Part-8) "Methods of test for soils: Determination of water content - dry density relation using high compaction" (Reaffirmed in May 2015).Estimation Each compacted specimen's bulk density, m in g/cm3, is computed

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using the equation below. (W2-W1)/Vm = m W1 = Mould + Base Plate Weight in Grams W2 = Mold + Base Plate + Soil Weight in Grams Vm = Mold Volume, i.e. 1000 cm3. 2. Each compacted specimen's dry density, d in g/cm3, is computed using the equation below. (100+M) d = 100 m/ Where m is the bulk density of dirt in grams per cubic metre. M = Soil moisture content

Sl no.	Description	1	2	3	4
1	Container no.	1	2	3	4
2	Container+ wet soil	24.06	24.04	22.42	22.94
3	Container+ dry soil	22.63	22.60	21.77	22.16
4	Weight of container	16.79	16.78	16.99	16.62
5	Water loss	1.43	1.44	0.65	0.78
6	Weight of dry soil	5.84	5.82	4.78	5.54
7	%of water content	24.5	24.7	13.6	14.1

5. CONCLUSIONS

To determine the benefits of stability, black cotton soils were tested with sand and cement. Cement, at a minimum of 2%, and sand, at a minimum of 10%, were applied to target soils at 10% intervals from 10% to 30%. Mechanical characteristics, Atterberg limits, Proctor compaction, UCC, and CBR were also tested. The results of the experimental inquiry reveal the following trends:

• Specific Gravity: of stabilised soil rose in general as fly ash content increased. There must be a reduction

• Liquid Limit: of stabilised soil fell significantly as sand and cement content increased. In black cotton soils, however, there should be a minor increase or decrease in sand and cement.

• The plastic limit of the stabilised soil dropped as the sand and cement concentration increased. However, at 20% sand and cement, the percentage drop in plastic limit is unrelated to the original plastic limit of the soils.

• Proctor Density: When around 30% of sand and cement is added, the OMC decreases and the MDD increases.

• Unconfined compressive strength: However, there is a progressive increase of 20% and a fall of 30% for unconfined compressive strength. Shear strength has decreased by 20% while increasing by 30%.

• California Bearing Ratio (CBR): The value of the CBR has decreased by 20% and increased by 30%.

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• The basic laboratory test findings revealed that the soil is classified as A-7-6 by HRB, with low permeability, low strength, and high volume change qualities.

• The density of black cotton soil did not change significantly when bagasse ash was added, but the CBR and UCS values did

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