International Journal For Technological Research In Engineering
Volume 9, Issue 10, June-2022 ISSN (Online): 2347 - 4718

# STABILIZATION OF SOFT CLAY SOIL BY USING POND ASH & GEOTEXTILE

Mr. K.ASHOK[1], N. MOHINI[2], M.SURESH BABU[3], M.NAGA KALYAN[4], SK. MUSTAFFA[5]
[1]Assistant Professor, [2,3,4,5] B.tech IV year Student
C.E Dept
Usharama College of Engineering& Technology
Telaprolu, Krishna District, Andhra Pradesh, India

***Abstract:* Now a day's Expansive soils are a worldwide problem for civil engineers. Over the last few years, the construction of highways and roads has taken a boost. This requires a huge amount of natural soil to excavated or to be deposited which is an environmental issue and economical too. This issue motivates in development of alternative methods and thus leads to the reuse of suitable industrial by products. Pond ash is one such by product. Expansive nature of black cotton soil generates lot many problems in pavement construction. Thus for good performance and long life of road it is important to improve the properties of black cotton soil. This study deals with improving the properties of black cotton soil through addition of Pond ash .which is an environmental friendly option. It causes damages to foundations, pavements etc. Due to disposal of plastic waste on soil and pollution, it reduces soil strength and causes various problems on soil. Soil stabilization is the way used to reduce problems in expansive soils. The present project describes about the properties of expansive soil and Pond Ash. Pond Ash is used as an additive material for stabilizing the soil. Stabilizing the soil by adding Pond Ash improves the soil strength and reduces swell and shrink. The main aim of this project is to study the effect of Pond Ash on expansive soil for road construction. The laboratory tests are carried to determine the index properties and engineering properties of soil sample. The soil samples are prepared with different proportions of Pond Ash as 10%, 20%, 30%, 40%, 50%, and 60%. The differential free swell index decreases by increasing the percentage of pond ash. It has 50% of free swell index. This degree of expansiveness, decreases from 50 % to 17.64 %.This is meant, when 50% pond ash is added in clay, the expansiveness decreases about 32.36 %. The dry density also increases up to 40% of pond ash and then decreases while adding pond ash. The ultimate dry density occurs at 40% of pond ash addition. CBR value also increases with increase in pond ash percentage. To increase the CBR percentage addition of geotextile at different depths is also done. As a result we get maximum at 3/4 depth from the bottom. Bearing capacity of the soil is also increased due to pond ash and geotextile at that particular depth.***

***Keywords:* Black cotton Soil, Soil expansion, Stabilization, Pond ash, Geotextile.**

## 1. INTRODUCTION

Expansive soils are mostly found in the arid and semi-arid regions and it covers very large area of the world. It covers nearly 20% of the landmass in India and includes almost the entire Deccan plateau, Western Madhya Pradesh, parts of Gujarat, Andhra Pradesh, Uttar Pradesh, Karnataka, and Maharashtra. The swelling soils are commonly known by the name of Black Cotton Soils. For swelling to occur, these soils must be initially unsaturated at some water content. If the unsaturated soil gains water content, it swells. On the other hand, if a decrease in water content occurs the soil shrinks. The presence of montmorillonite clay in these soils imparts them high swell–shrink potentials.

The Malwa region occupies a plateau in western Madhya Pradesh and south-eastern Rajasthan, with Gujarat in the west. To the south and east is the Vindhya Range and to the north is the Bundelkhand upland. The plateau is an extension of the Deccan Traps, formed between 60 and 68 million years ago at the end of the Cretaceous period. In this region the main classes of soil are black, brown and bhatori (stony) soil. The volcanic, clay-like soil of the region owes its black colour to the high iron content of the basalt from which it formed. The other two soil types are lighter and have a higher proportion of sand..

In the olden days i.e., before the existence of geotechnical engineering the only way to use a ground is to construct the structures where the soil suitable to our need. But after the advancement in the civil industry a subject developed regarding the improvements of the ground which is called ground improvement techniques which deals with the various improvement techniques by which the land that can be made into desired properties. On the basis of geotechnical engineering all the lands are mainly classified into 3 types:

1. Good soil

2. Bad soil

3. Hazardous soil

Good soil in the sense which is to be used as it is to the construction without any improvement. Bad soil means the land in which the desired properties may not present which is used for the construction by application of any improvement technique through which we can change the properties like bearing strength, compressibility, permeability, consolidation, shrinkage, drainage etc into desired limits. Hazardous soil is the soil which is completely unfit for the construction because of its toxicity, radiation properties which may harm to the persons or any structures surrounding it. It is completely avoided for the construction purpose. We know the soil strata is non-uniform throughout the country, different parts of the country have different soils which may suitable / unsuitable for the construction. Weak clayey and compressible soils with low strength characteristics cause serious construction problems resulting in failure of the structures constructed over them. Availability of good soil, for development of civil infrastructure is scarce due to the ever increasing population demand for the land and other economical factors. In such cases, it is required to enhance the strength properties of these weak soils. To enhance the strength properties, the soil can be stabilized either by chemical stabilization or mechanical stabilization. With the use of ground improvement techniques we can improve the nature of the ground and make them suitable for the construction. Different types of stabilization materials are used from past years like cement, lime, bitumen, fly ash, blast furnace slag, and pozzolonas. With the advancement in technology several new soil stabilization materials are developed.

Pond Ash

In the thermal power plants the coal is burnt to heat the water for making the steam, which in turn is used to run the turbines. The pond ash is a waste product from the boilers. It is mainly obtained from the wet disposal of the fly ash, which when get mixed with bottom ash is disposed off in large pond or dykes as slurry. The pond ash is being generated in an alarming rate. The generation of the pond ash is posing a lot of threat to environment and thus its sustainable management has become the thrust area in engineering research. As the pond ash is relatively coarse and the dissolvable alkalies present in it are washed with water, its pozzolanic reactivity becomes low and hence it is not preferred as part replacement of cement in concrete as in the case of fly ash. Pond ash is a waste material collected from the ash ponds of thermal power plants. Pond ash is a non-plastic and light weight material having a specific gravity relatively lower than that of similar graded conventional earth material.

It is a mixture of fly ash and bottom ash that is sluiced to large storage ponds. Fly ash is a fine coarse, glass powder recovered from the gases of burning coal during the production of electricity. These micronized earth elements consist primarily of silica, alumina and iron. The basic and essential parameters of pond ash, to be used in geotechnical constructions, are the compaction characteristics, strength properties. The pond ash is a waste product from boilers, where the coal is burnt to heat the water for preparing the steam, which is a common process in most of coal, based thermal power plants. It is mainly obtained from the wet disposal of fly ash. The fly ash gets mixed with bottom ash and disposed of in large pond or dykes as slurry.

Since, pond ash is the residue after combustion of coal in thermal power plants, so its properties depends upon the coal used and may vary from one power plant to other power plant. Particle sizes of the ash vary from around one micron to around 600 microns. The very fine particles (fly ash) collected from this ash generated by electrostatic precipitators are being used in the manufacture of blended cements. Unused fly ash and bottom ash (residue collected at the bottom of furnace) are mixed in slurry form and deposited in ponds which are known as pond ash . About 120 million tons of pond ash is produced in India .This huge amount of industrial waste can cause serious hazards to the world. The fly ash and pond ash are one of the responsible pollutants of air, soil and water. These wastes require huge space for their disposal. Therefore it is necessary to increase the constructive use of these wastes in construction industry. About 25% is utilized for Roads, Buildings and other Civil engineering applications. Bulk utilization of Pond ash is being carried out for road embankment construction in the ongoing massive road development programs taken up by the Government of India viz. National Highway Development Program (NHDP) and PradhanMantri Gram SadakYojana (PMGSY) (Havanagi et al. 2011). Many studies are done to evaluate the effect of the pond ash on the behaviour of soil. All researchers have reported that soil mixed with pond ash can used in different applications like for construction of embankment, under foundation or as fill material etc.

This large volume of Pond ash causes various environmental and significant economic problems. It can be used for stabilization of soil with appropriate amount of lime or cement and decrease the cost of pavement and foundations.

Geotextiles

As we know, the prefix of geotextile, geo, means earth and the ‘textile’ means fabric. Therefore, according to the definition of ASTM 4439, the geotextile is defined as follows: "A permeable geosynthetics comprised solely of textiles. Geotextiles are used with foundation, soil, rock, earth, or any other geotechnical engineering-related material as an integral part of human-made project, structure, or system." Geotextiles type one among the 2 largest teams of Geosynthetics. Their rise in growth throughout the past 35years has been nothing wanting extraordinary. They're so textiles within the ancient sense, however they comprises artificial fibbers instead of natural ones like cotton, wool, or silk. Thus, biodegradation and resultant short life is eliminated. These artificial fibres are created into versatile, porous materials by normal weaving machinery or are matted along during a random non-woven manner. Some also are unwoven. There are at-least a hundred specific application areas for geotextile that are developed. Geotextiles are classified based on manufacturing process into the following:

- Woven GT
- Non-woven GT
- Knitted GT
- Stitched GT

  

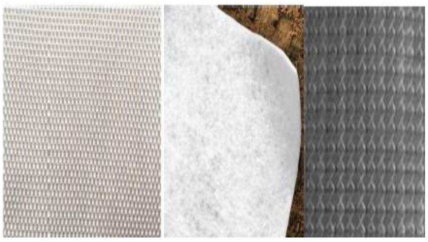

Figure 1: Geotextiles

## 2. METHODOLOGY

Methodology mainly consists of 3 parts. Part 1 includes identification of problems in construction of roads in black cotton soil, review of literatures, and collection of soil & pond ash. Part 2 & 3 are laboratory works which are mainly focused on determination of index properties, & engineering properties of soil.

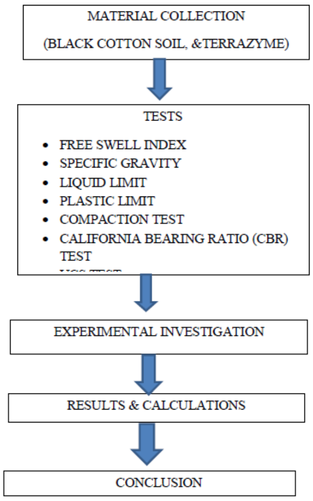


Figure 2. Methodology Flow Chart

**Collection of Materials**

The expansive soil (Black cotton soil) used for this project was taken from Kanuru Place Surroundings Krishna District. The locations had been selected for collecting one soil sample from the particular area. The black cotton soil was collected from a depth of 1m. About 100kg of soil sample was collected. Pond ash used in this study was collected from the ash pond of NTTPS thermal
Power plant at Ibrahimpatnam, Vijayawada.

**Laboratory California bearing ratio (CBR) (IS 2720-Part 16)**

APPARATUS:

1. Loading machine: This is compression machine, which can operate at a constant rate of 1.25mm per minute. A metal penetration piston or plunger of diameter 50mm is attached to the loading machine.

2. Cylindrical mould: Mould of 150mm diameter and 175mm diameter provided with a collar of about 50mm length and a detachable base. A spacer disc of 148mm diameter and 47.7mm thickness is used to obtain a specimen of exactly 127.3mm height.

3. Compaction rammer

4. Annual weight: In order to simulate the effect of the overlying pavement weight, annular weights each of 2.5kg weight and 147mm diameter are placed on the top of the specimen, at the time of testing the sample, as surcharge.

PROCEDURE:

a. Preparation of sample:

1. Take about 5 kg air dried soil which is pulverized and passed through 4.75mm sieve.

Add to this soil a certain percentage of water based on the optimum moisture content found out by the compaction test. Sprinkle this water uniformly on the soil and mix it carefully.

3. Divide the wet soil into five equal parts fill the mould with one part of soil and compaction it with 55 evenly distributed blows with the rammer.

4. Repeat the above process with the second, third, fourth and fifth parts of the soil.

5. Before each subsequent layer of the soil is placed the top of the previously compacted layer is scratched with a spatula. This ensures a thorough bonding of one layer with the other. The mould is thus filled with all the five soil layers.

6. Once the sample is prepared the mould with base plate is immersed in a soaked beaker full of water with a circular on it for a period of 4days.

b. CBR test:

1. After 4 days take out the sample and leave it in the atmosphere for the period of half an hour.

2. Remove the base plate and place the mould in the CBR apparatus and place surcharge weights of 2.5 or 5kgs.

3. Make sure that the plunger touches the top surface of the soil. Attach the dial gauge and proving ring.

4. Switch on the lever and set the application load as per penetration rate 1.25mm per minute.

5. Observe the reading dial gauge at every 0.5mm and note the corresponding proving ring dial reading. Until the failure occurs.

CALCULATION FORMULA:

CBR (%) = Load carried by soil sample at defined penetration level *100/
Load carried by standard crushed stones at the above penetration level

The load penetration curve is plotted in natural scale for the taken specimen. If the curve is uniformly convex upwards no correction is needed. In case there is a reverse curve or the initial portion of the curve is concave upwards necessity of correction is indicated. A tangent is drawn from the steepest position on the curve to intersect the base at point y which is corrected origin corresponding into zero penetration. The load values corresponding to 2.5 and 5mm penetration values are found from graph. The CBR value is calculated by the above formula.

Generally the CBR value at 2.5 mm is higher and this value is adopted .However if higher CBR value is obtained at 5mm penetration the test is repeated to verify the results. If the value is 5mm is again higher this is adopted as CBR value of the soil sample.

Figure 3. Compaction of Soil Sample

Figure 4. Readings taking

**UNCONFINED COMPRESSION TEST**
**APPARATUS:**
• Loading frame with constant rate of movement
• Proving ring of 0.01 kg sensitivity for soft soils ; 0.05 kg for stiff soils
• Soil trimmer, evaporating dish
• Frictionless end plates of required diameter
• Dial gauge (0.01 mm), vernier calipers
• Balance of capacity 200 g and sensitivity to weigh 0.01 g
• Oven ,thermostatically controlled with interior of non-corroding material
• Soil sample of required dimensions,sample extractor and split sampler

**PROCEDURE**
• In this test, a cylinder of soil without lateral support is tested to failure in simple compression ,at a constant rate of strain.
• The compressive load per unit area required to fail the specimen as called unconfined compressive strength.
• Take two frictionless bearing plates of 75mm diameter.
• Place the specimen on the base plate of the load frame.
• Place a hardened steel ball on the bearing plate.
• Adjust the center line of the specimen such that the proving ring and steel bar are in same line.
• Fix a dial gauge to measure the vertical compression of the specimen.
• Adjust the gear position on the load frame to give suitable vertical displacement.
Start applying the load and record the readings of the proving ring dial and compression dial for every 5mm.
• Continue loading till failure is completed.
• Draw the sketch of the failure pattern in the specimen.

Figure 5. UCS TEST

Figure6. Reading of UCS TEST

## 3. RESULTS & DISCUSSION

**INDEX PROPERTIES OF BLACK COTTON SOIL**
**Free Swell index Test:**
APPARATUS:

- 425 micron IS sieve.
- Graduated glass cylinders 100 ml capacity 2Nos (IS: 878 -1956).
- Glass rod for stirring.
- Balance of capacity 500grams and sensitivity 0.01 gram.

Table 1: Free swell index For BCS with Different Percentages of Pond Ash

| Test Specimen | Distilled water (Vd) ml | Kerosene (Vk) ml | Free swell index (%) |
|---|---|---|---|
| BCS | 12 | 8 | 50% |
| BCS + 10% PA | 12 | 8.5 | 41.17% |
| BCS + 20% PA | 11.5 | 8.5 | 35.29% |
| BCS + 30% PA | 10 | 8 | 25% |
| BCS + 40% PA | 10 | 8.5 | 17.64% |
| BCS + 50% PA | 10 | 9 | 11.11% |

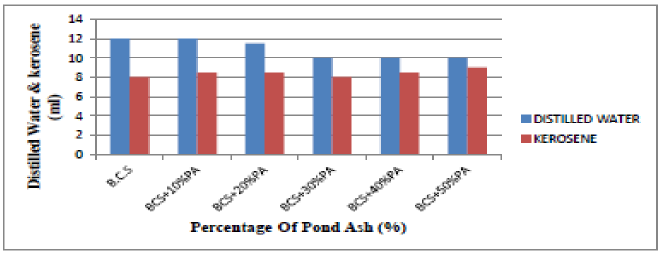


Figure 7. Free Swell index

  

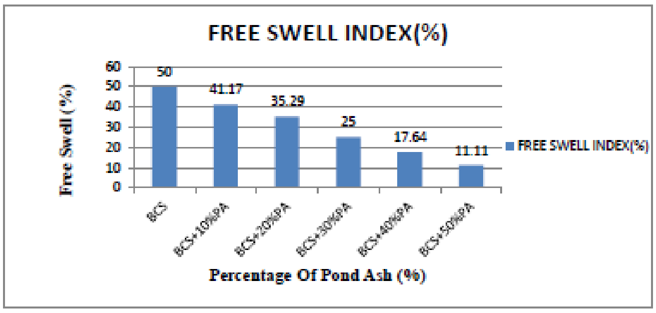


Figure 8. Variation of Free Swell index

**Specific gravity of black cotton soil**

Density bottle of 50ml capacity

**Table 2: Specific gravity**

| | |
|---|---|
| Weight of empty density bottle ($W_1$ g) | 27 |
| Weight of density bottle+ soil ($W_2$g) | 37 |
| Weight of density bottle+ soil + water ($W_3$ g) | 83 |
| Weight of density bottle + water ($W_4$ g) | 76.7 |
| Specific gravity ($G_S$) | 2.7 |

**Liquid limit**

**Comparison Of all Liquid Limit Tests:**

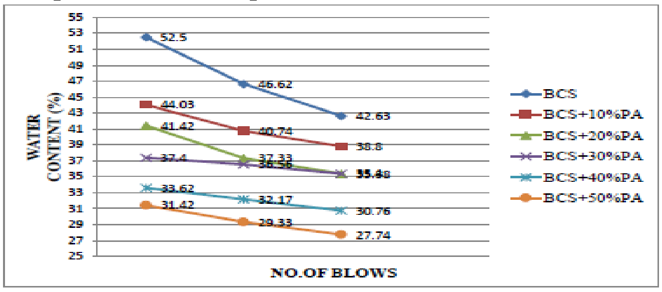


Figure 9. All Liquid Limit comparison

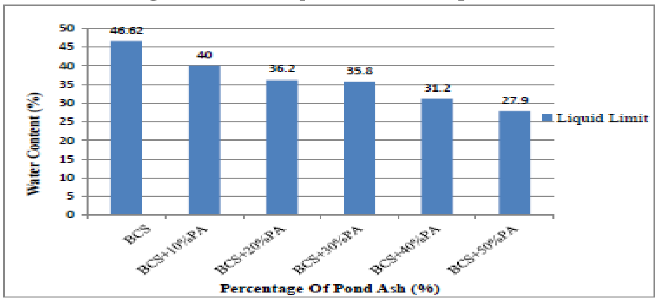


Figure 10. Liquid Limit Bar graph For Different Percentages (%) of Pond Ash

**Plastic limit**

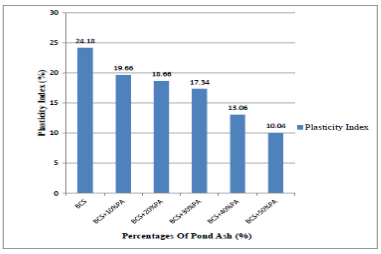


Figure 11. Plastic Limit Bar graph For Different Percentages (%) of Pond Ash

**Compaction test:** The results obtained in the compaction test were presented here.

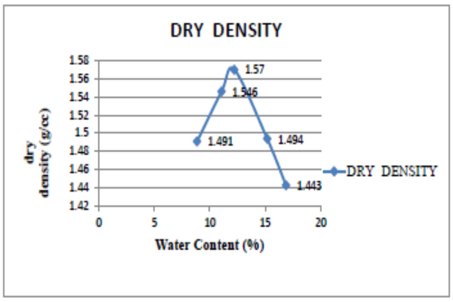


Figure 11.Max Dry Density

From the graph the maximum dry density of 1.57g/c.c. was obtained at an optimum moisture content of 12.22%.

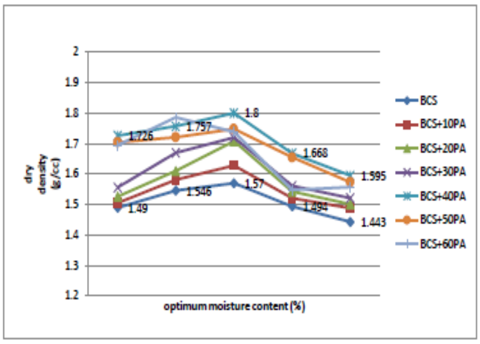


Figure 12. All Compaction Comparison for Dry Density (g/cc)

**Maximum Dry Density :**

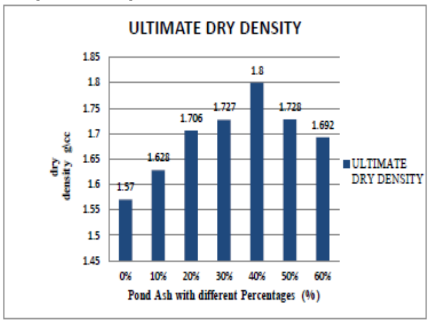


Figure 13. Comparison of maximum dry density (g/cc)

**OPTIMUM MOISTURE CONTENT:**

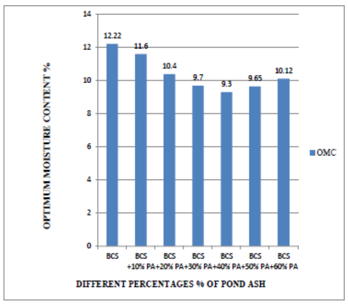


Figure 14. Comparison of Optimum moisture content

From the graph it was very clear that for the 40 % of Pond Ash the Maximum Dry Density of 1.80 g/cc was obtained at an optimum moisture content of 9.3 %.

  

**CBR Tests**
**Unreinforced Soil (Soaked)**

Table 3: CBR test Soaked
(Black Cotton Soil)

| Dial gauge reading | Penetration in mm | Proving Ring reading | Load (kg) PX6.887 |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
| 50 | 0.5 | 2 | 13.774 |
| 100 | 1 | 3 | 20.661 |
| 150 | 1.5 | 5 | 34.435 |
| 200 | 2.0 | 8 | 55.096 |
| 250 | 2.5 | 11 | 75.757 |
| 300 | 3.0 | 12 | 82.644 |
| 400 | 4.0 | 13 | 89.531 |
| 500 | 5.0 | 15 | 103.305 |
| 700 | 7.0 | 19 | 130.853 |
| 1000 | 10.0 | 22 | 151.514 |
| 1200 | 12.0 | 25 | 172.175 |

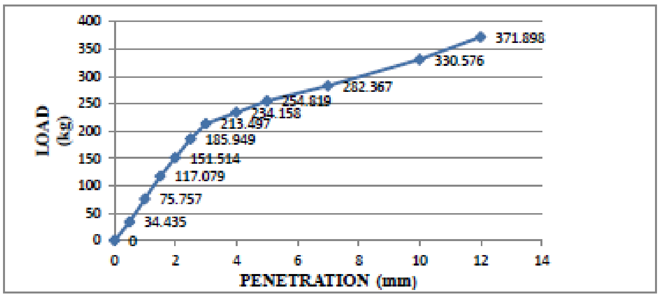


Figure 15. Unreinforced soaked CBR for BCS

## 4. CONCLUSIONS

The basic engineering properties of the Black Cotton Soil and pond ash was studied

- The clay has been tested for 0%,10%,20%,30%,40%,50% of pond ash added to the soil
- thus the free swell index values are 50%,41.17%,35.29%,25%,17.64%,11.11%
- respectively.
- Thus the differential free swell index decreases by increasing the percentage of pond ash.
- Therefore, the clay is having high degree of expansiveness and the value is 50 %. This
- degree of expansiveness, decreases from 50 % to 17.64 %.This is meant, when 50% pond ash is added in clay, the expansiveness decreases about 32.36 %.
- From the test, the liquid limit values of black cotton soil with 0%, 10%, 20%, 30%, 40%, 50% of pond Ash are 46.62%, 40%, 36.25%, 35.8%, 31.2%, and 27.9% respectively.
- From the test results the type of soil as per ISSCS that we are using for this test is Intermediate Compressible Clay (IC) because it's liquid limit (46.62%) (Which is in
- between 35-50% - intermediate Compressible) and it's Ip (24.18%) < (Ip)A (17.65%) (Clay).
- The average plastic index of the black cotton soil is 22.44% and its plasticity index is 24.18%.
- From the test, the plastic limit values of black cotton soil with 10%, 20%, 30%, 40%, 50% of pond ash are 20.34%, 18.66%, 18.45%, 18.14%, 17.86% respectively.
- Therefore from the comparison of all the percentages of the pond ash, the liquid limit and plastic limit value of addition of 40% of Pond Ash on soil is less than the
- conventional. Plastic limit (31.20%) and it's Ip (13.06%)
- From the compaction test for black cotton soil, the maximum dry density is 1.57g/cc and its moisture content is 12.22%
- the compaction test, the maximum dry density values of black cotton soil with 10%, 20%, 30%, 40%, 50% and 60% of pond ash are 1.628g/cc, 1.706g/cc, 1.72g/cc, 1.80g/cc,
- 1.728g/cc and 1.738g/cc respectively.
- the compaction test, the moisture content values for 10%, 20%, 30%, 40%, 50% and 60% of pond ash are 11.6%, 10.4%, 9.7%, 9.3%, 9.65% and 7.24% respectively.
- From the tests, it is clearly seen that the dry density increases by adding pond ash & eventually moisture content also decreased.
- Therefore from comparing all the values the maximum dry density 1.80 g/cc is obtained for 40% pond ash mix specimen at 9.3% moisture content. From the proctor compaction test, the maximum dry density is increased up to the 40 % of pond ash after above the percentage dry density decreases.

## REFERENCES

1. **Hima Latheef*, Asst Prof.Dipin Syam (2016)**describes "A STUDY ON STRENGTH CHARACTERISTICS OF SOIL REPLACED WITH PONDASH AND REINFORCED WITH COIR FIBRE"
2. **Girish Dinkar Patil,& Sushma Shekhar Kulkarni (2015)**describes about ."PERFORMANCE ANALYSIS OF POND ASH ASPARTIAL REPLACEMENTTO BLACK COTTON SOILFOR PAVEMENT SUBGRADE CONSTRUCTION**".**
3. **C.RadhaiDevi, S.Surendhar, et.al (2018),** "BOTTOM ASH AS AN ADDITIVE MATERIAL FOR STABILIZATION OF EXPANSIVE SOIL"
4. **S. Muthu Lakshmi, et.al (2018),** "AN EXPERIMENTAL STUDY ON SOIL STRENGTH ENHANCEMENT USING GEOSYNTHETICS".
5. **Aneesha Aseez et.al (2018),** "STRENGTHENING OF SUBGRADE SOIL USING GEOSYNTHETICS"
6. **Selma James, Rakendu R (2018)**, "GEOTEXTILE REINFORCED TWO LAYER SOIL SYSTEM WITH KUTTANAD CLAY OVERLAIN BY LATERITE SOIL".
7. https://www.researchgate.net/file.PostFileLoader.html?id=5614fd1160614bbbfe8b45c9&assetKey=AS%3A281876829884417%401444216081230
8. https://nptel.ac.in/courses/105106052/downloads/Lecture-6.pdf

  