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Paper Authors

B.V.S.KOUSIC , DR. CH.BHAVANNARAYANA

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STABILIZATION OF EXPANSIVE SOIL BY USING POLYPROPYLENE FIBER WITH GROUND NUT SHELL ASH

B.V.S.KOUSIC *, DR. CH.BHAVANNARAYANA **
*PG Scholar , Kakinada Institute of Engineering and Technology - II, Korangi, Kakinada
** Professor & HOD, Kakinada Institute of Engineering and Technology - II, Korangi, Kakinada

ABSTRACT: Expansive soil is more swells whenever contacts water and shrinks water evaporates. Severe damages occur to structures like light building, pavements, retaining walls, canal beds and linings etc. founded on the expansive soils. Soil stabilization may be defined as any process by which a soil material is improved and made more stable resulting in improved bearing capacity, increase in soil strength, and durability under adverse moisture and stress conditions. The wastes which are solid in nature and remain at the place of their disposal are called as solid wastes. They may be divided into four groups based on the source of their generation i) Industrial solid wastes (Fly ash, Blast furnace slag, Red mud, Copper slag, polyethylene waste, quarry dust etc.) ii) Agricultural solid wastes (Rice husk, Bagasse, Ground nut shell etc.) iii) Domestic solid wastes (Incinerator ash, Waste tire etc.) and iv) Mineral solid wastes (Quarry dust, Marble dust etc.). Stabilization using solid wastes is one of the different techniques to improve the engineering properties of expansive soils to make them suitable for construction.

The leading attempt of this paper is to investigate the Engineering properties of the expansive soil blending with polypropylene Fiber (PF) along with Ground nut Shell Ash(GSA) at different proportions. In the present study three different percentage of polypropylene Fiber (0.25%, 0.5% ,0.75% and 1%) by weight of dry soil and three different percentage of Ceramic Dust (0%, 5%, 10%, 15% and 20%) by weight of dry soil were studied. It is identified that due to the addition of polypropylene fiber, CBR strength has been increased up to desired strength level by adding the various % of PF and GSA. The tests are to be conduct, CBR, UCS with 1, 7, 14 days curing and model test tank study. It was observed that the atterberg limits are varied by the addition additives to the expansive soils. The Results of CBR increasing by increasing the materials to the expansive soils up to the optimum. Settlements decreased and load bearing value increased by the addition of materials to the expansive soils.

Key words: Ground nut shell, CBR, polypropylene Fiber

1. INTRODUCTION

1.1 Expansive soils:

Expansive soil is one among the problematic soils that has a high potential for shrinking or swelling due to change of moisture content. Expansive soils can be found on almost all the continents on the Earth. Destructive results caused by this type of soils have been reported in many countries. In India, large tracts are covered by expansive soils known as black cotton soils. The major area of their occurrence is the south Vindhyachal range covering almost the entire Deccan Plateau. These soils cover an area of about 200,000 square miles and thus form about 20% of the total area of India. The primary problem that arises with regard to expansive soils is that deformations are significantly greater than the elastic deformations and they cannot be predicted by the classical elastic or plastic theory. Movement is usually in an uneven pattern and of such a magnitude to cause extensive damage to the structures resting on them.

In India, the area covered by expansive soil is nearly 20% of the total area. The expansive soils normally spread over a depth of 2 to 20m. In rainy season, they undergo heave and lose weight. In summer, they shrink and gain density and become hard. This alternate swelling and shrinkage damage the structures severely. This is more severe for the light structures.

During summer, polygonal cracks are appear at the surface, which may extend to a depth of about 2m indicating the active zone in which volume change occurs. The depth of active zone defined as the thickness of the soil below the ground surface within which moisture content variations and hence volume changes do take place. Sustained efforts are being made all over the world on highway research field to evolve more promising treatment methods for proper design and construction of pavements running over expansive soil sub grade.

1.2 Characterization of Expansive Soils

Field Identifications:

- Color: May be black, grey, yellow grey.
- During summers, side and deep map type cracking is observed.
- During heavy rains, when such soils get saturated, it would be very difficult to work through these soils because of high stickiness.
- Normally the slope of terrains very flat in the range of 0^0 to 2^0.
- Drainage is very poor.

In India, the vegetation in such area may consist of thorns, bushes, thorny trees (babul) cactus etc. Buildings constructed on such deposits exhibits heaving of floor lifting of columns and walls usually accompanied by cracking. Doors normally jammed during rainy season. In case of canals in embankments, partial cuts or in cutting, bed heaving accompanied by cracking of the bed concrete is observed. Heavy sliding accompanied by progressive failures is observed on the sides. Retaining structure show tilting and distress road get rutted.

2. SOIL STABILISATION

2.1 Definition

Soil stabilization is the process of altering some soil properties by different methods, mechanical or chemical in order to produce an improved soil material which has all the desired engineering properties.

Soils are generally stabilized to increase their strength and durability or to prevent erosion and dust formation in soils. The main aim is the creation of a soil material or system that will hold under the design use conditions and for the designed life of the engineering project. The properties of soil vary a great deal at different places or in certain cases even at one place; the success of soil stabilization depends on soil testing. Various methods are employed to stabilize soil and the method should be verified in the lab with the soil material before applying it on the field.

Soil is one of nature's most abundant construction materials. Almost all constructions is built with or upon soil. When unsuitable construction conditions are encountered, a contractor has 4 options.

(1) Find a new construction site.

(2) Redesign the structure so it can be constructed on the poor soil.

(3) Remove the poor soil and replace it with good soil.

(4) Improve the engineering properties of the site soils.

2.2 Principles of Soil Stabilization:

- Evaluating the soil properties of the area under consideration.
- Deciding the property of soil which needs to be altered to get the design value and choose the effective and economical method for stabilization.
- Designing the Stabilized soil mix sample and testing it in the lab for intended Stability and durability values.

2.3 Uses of Soil Stabilization

Traditionally, stable sub-grades, sub-bases and bases have been constructed by using selected, well-graded aggregates, making it fairly easy to predict the load-bearing capacity of the constructed layers. By using select material, the engineer knows that the foundation will be able to support the design loading.

Gradation is an important soil characteristic to understand. A soil is considered either "well-graded" or "uniformly-graded" (also referred to as "poorly-graded"). This is a reference to the sizes of the particles in the materials. Uniformly-graded materials are made up of individual particles of roughly the same size. Well-graded materials are made up of an optimal range of different sized particles. The addition of lime slurry is a form of chemical soil.

2.4 Different Type of Stabilization

i). Mechanical stabilization
ii). Physical stabilization
iii). Chemical stabilization

2.5 Polypropylene fibre:

Polypropylene fiber is used in this study and it is a synthetic material. Fibers used for this study has a length of 12mm were purchased from the market. Polypropylene fibers are hydrophobic, non-corrosive and resistant to alkalis, chemicals and chloride

Polypropylene fibers having lengths 6, 12 and 24 mm, and aspect ratio of 150,300 and 600 respectively were purchased from the market for use in experimental programme.

Figure 1: shows the polypropylene fibre

2.6 Ground nut Shell Ash (GSA): Ground nut shell ash was partially used cement in concrete. GSA will considerably reduce the cost of construction and as well as reduce or eliminate the environmental hazards caused by such waste. Shell digestibility is quite low; research efforts are being directed to improve it as it contains more than 60 percent fibre. Inoculation and biodegradation of shell have been tried but these efforts have been success[13-19], the percent of unbleached pulp yield on an average 93 percent of alpha-cellulose from groundnut shell.

Figure 2: shows the Ground nut shell ash

3. REVIEW LITERATURE

A.PARVATHY KARTHIKA(2018),studied to find the use of Groundnut shell ash as a stabilizing agent for improving the properties of soil. Groundnut shell is an agricultural waste obtained from the milling groundnut. Groundnut shell ash generated from the burning of groundnut in open air for 4 hours. Few attempts have been made with groundnut shell ash with the combination of other materials on soil stabilization, but very scanty attempts have been made to work on only with groundnut shell ash on soil stabilization. %. In our project, groundnut shell ash was added from 2% to12% at 2% interval to soil and examining the optimum percentage of groundnut shell ash. The index properties of the soil are liquid limit, plastic limit, shrinkage limit, free swell index and specific gravity are done. The optimum usage of groundnut shell ash added to the soil is 6%.

K.Venkatraman et al 2018, studied an attempt is made to know the effect of groundnut shell ash in the clay soil, to examine the load bearing capacity of the soil when combined with groundnut shell ash, to analysis the clay soil and its effect with groundnut shell ash in different percentages such as 5%,10%,15%. From the optimum moisture content of the clay soil the groundnut shell ash is added in different percentages, to determine the soil bearing capacity with and without groundnut shell ash by plate load test. As groundnut is easily available material and an Eco friendly product, it is used in this study which is also economically cheap. Groundnut shell ash and cement increased the optimum moisture content. There was a slight decrease in the dry density and modulus of elasticity of soil

4. MATERIALS & METHODOLOGY

4.1 Materials

Soil

The black cotton soil collected from '**Thummalapalli**' village near Amalapuram, East Godavari District in India. The properties of the soil are given in Table

Table 1: Properties of Expansive Soil

Property	Value
Grain size distribution	
Sand (%)	5
Silt (%)	17
Clay (%)	78
Atterberg'S limits	
Liquid limit (%)	78
Plastic limit (%)	35
Plasticity index (%)	43
Compaction properties	
Optimum Moisture Content, O.M.C. (%)	22.50
Maximum Dry Density, M.D.D (g/cc)	1.35
Specific Gravity (G)	2.70
IS Classification	CH
Soaked C.B.R (%)	2.0
Un-Soaked CBR (%)	2.8
Differential free swell (%)	130

Polyethylene waste:

Plastic fibres were obtained from waste plastic cover (milk and curd packets). After proper cleaning and air drying, the plastic covers were shred into fibers each of average thickness of 2mm. These plastic covers are usually considered to be waste materials.

5. DISCUSSION ON TEST RESULTS

5.1 Introduction

Details of the laboratory experimentation carried-out with different combinations of materials have been discussed in the previous chapter including the laboratory static plate load tests on untreated and treated expansive clay foundation beds.

In this chapter a detailed discussion on the results obtained from various laboratory tests are presented including the results of laboratory static plate load tests on untreated and treated expansive clay sub grade foundation beds.

5.2. Laboratory Test Results

5.2.1 General

In the laboratory, index tests, swell tests, strength tests were conducted by using different percentages of polypropylene fiber and Ground nut Shell Ash with a view to determine the optimum percentages of polypropylene fiber and Ground nut Shell Ash and strength Properties are discussed in the following sections.

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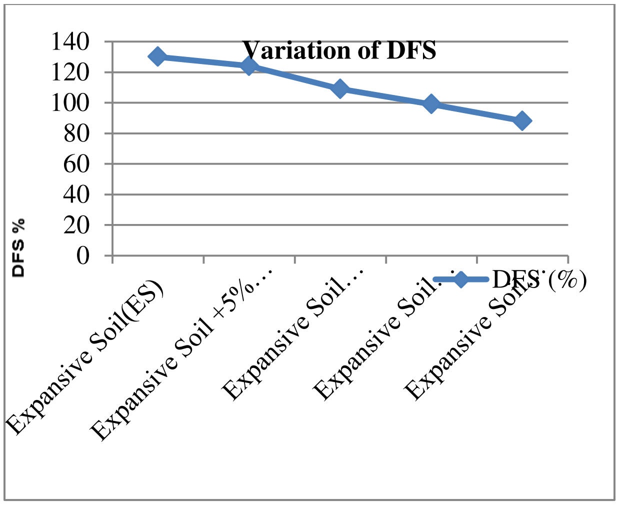
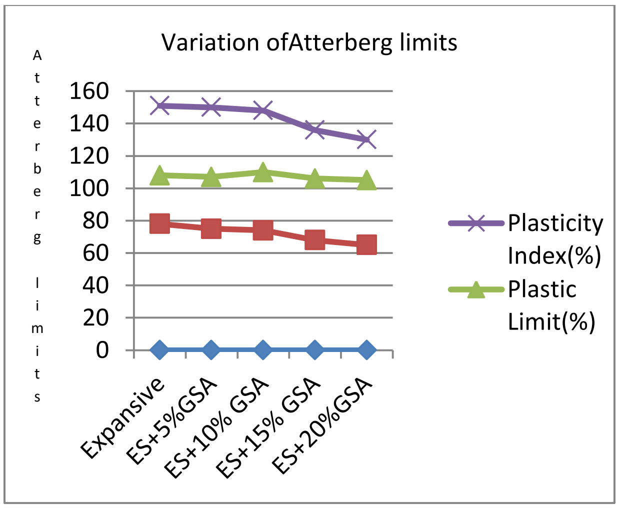
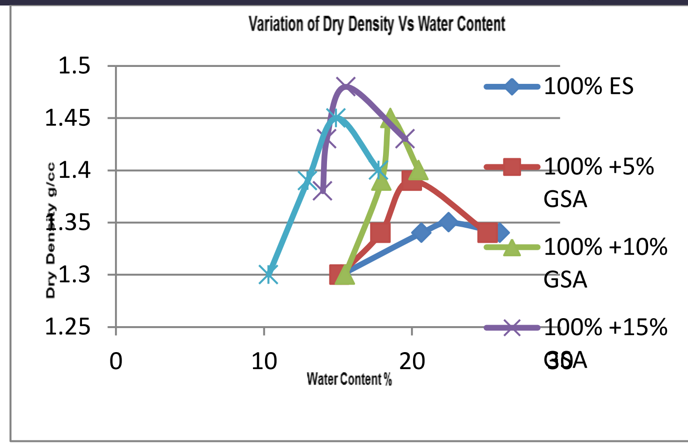
Additives	Percentage
Polypropylene Fiber	0.25%, 0.5%, 0.75% and1.0%
Ground nut Shell Ash	5%, 10%, 15% and 20%



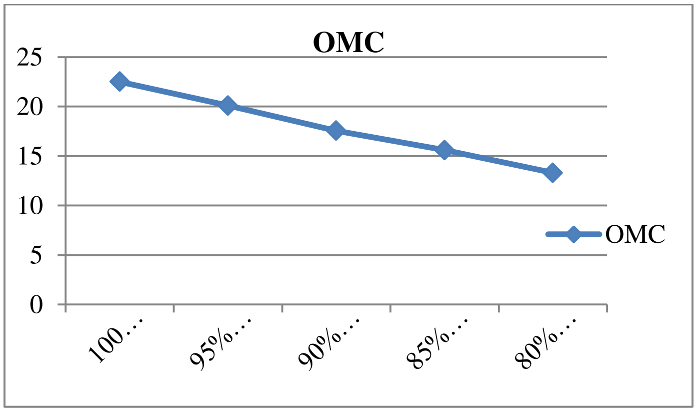
Graph 1 shows the variation of DFS with the addition of gsa



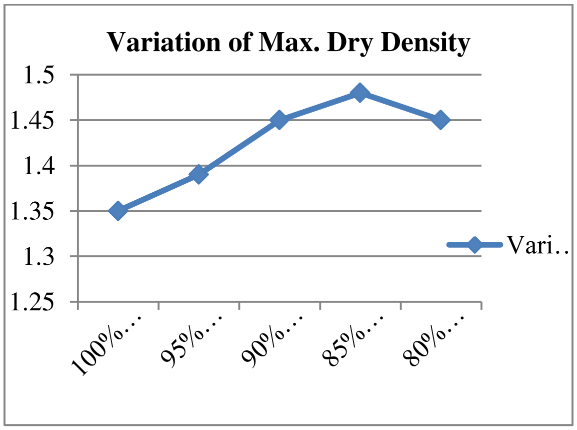
Graph 2 shows the variation of Atterberg limits with the addition of GSA



Graph 3 Variation of Dry Density and Water Content by addition of Ground nut Shell Ash (GSA)



Graph 4 shows the variation of OMC with the addition of GSA



Graph 5 shows the variation of OMC with the addition of GSA

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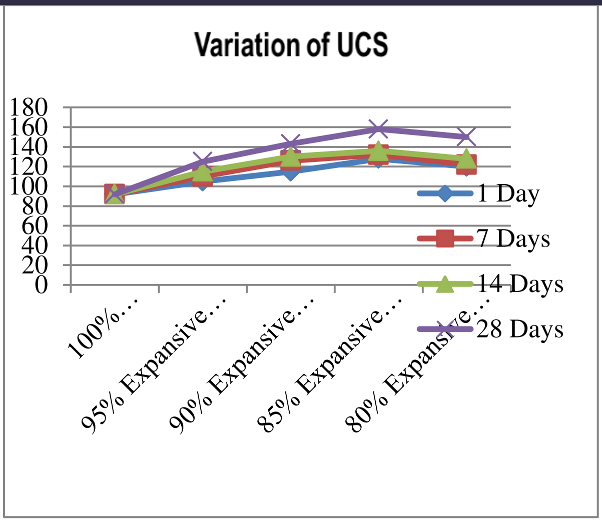
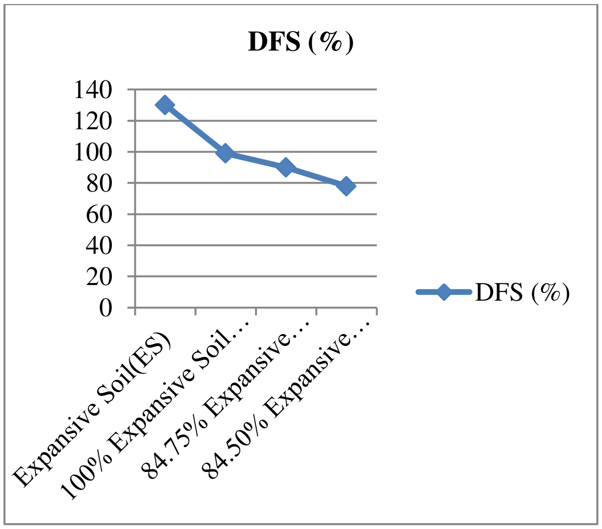


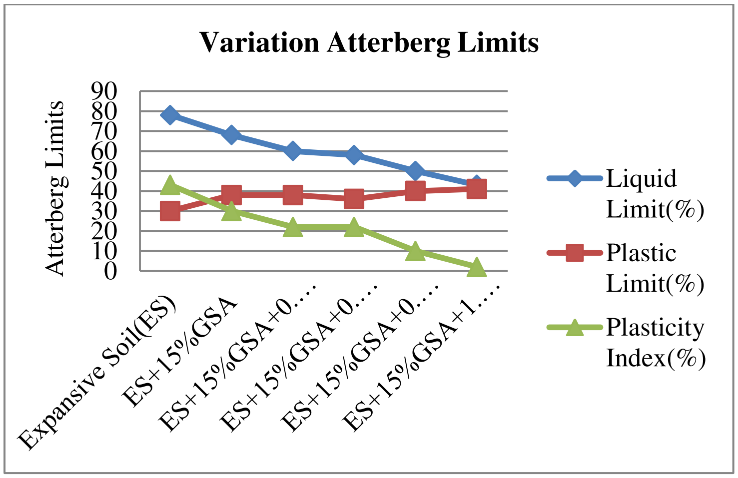
Graph 6 shows the variation of UCS with the addition of GSA

The Optimum Percentages of are Presented in the Following

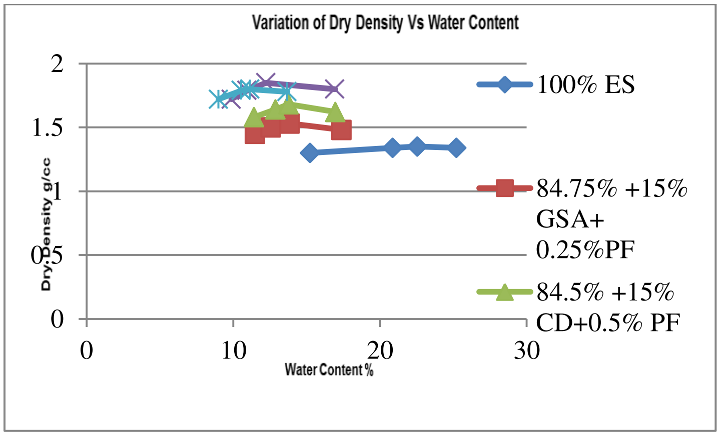
Additives	Optimum Percentage
Ground nut Shell Ash	15%



Graph 7 shows the variation of DFS with the addition of optimum of GSA &different percentages of PF



Graph 8 shows the variation of Atterberg limits with the addition of optimum of GSA & different percentages of PF



5.9 Effect of Ground nut Shell Ash(GSA) and Polypropylene Fiber (PF) on Compaction Properties

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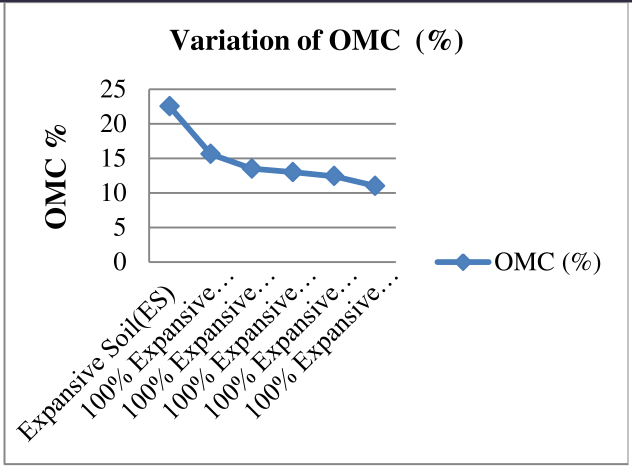
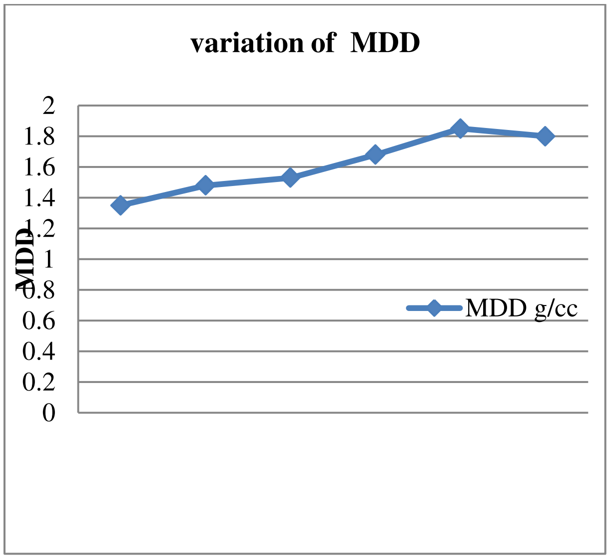


Graph 10 shows the variation of OMC with the addition of GSA &of optimum of GSA & different percentages of PF



Graph 11 shows the variation of OMC with the addition of GSA &of optimum of GSA & different percentages of PF

6. CONCLUSIONS

6. GENERAL

The following conclusions are made based on the laboratory experiments carried out in this investigation.

6.1 CONCLUSIONS

- Fig.5.1 shows the variation of **Atterberg Limits** of stabilized expansive soil with addition of different percentages of additives. It is can be observed that the Atterberg Limits are varying with increasing percentage of additives added to the expansive soil.
- It is observed that the decrease in the **liquid limit** is significant upto**15%GSA+0.75%PF**, beyond that there is a nominal decrease. The percentages increase of liquid limit with treated soil is **56%.**
- Nominal increase in **plastic limit** of stabilized expansive clay is observed with increase the percentage of the additives. Fig .5.1. The percentages decrease of plastic limit with treated soil is **33.33%.**
- The increase in the plastic limit and the decrease in the liquid limit cause a net reduction in the plasticity index. It is observed that, the reduction in **plasticity indexes** decrease **330%** respectively for **15%GSA+0.75%PF** added to the expansive clay.
- It is observed that the **DFS is decreasing** with increasing percentage of additives added to the expansive soil. Significant decrease in D.F.S. is recorded in stabilized expansive clay with addition of 20%GSA+1.0%PF. The reductions in the DFS of stabilized expansive clay in percentages is **62.50%**
- It is can be seen that the CBR is increasing with increasing percentage

of additives added to the expansive soil. Significant increase in CBR is recorded in stabilized expansive soil with addition of additives up to **15%GSA+0.75%PF**, beyond this percentage the increase in CBR is marginal. The increase in the strength with addition of additives is **240%**

- Compaction tests were conducted to get the Optimum moisture content and Maximum dry density by adding different proportions of additives to expansive soil using modified proctor compaction apparatus. The optimum percentages of both combinations are 15% of Ground nut Shell Ash and 0.75% Polypropylene Fiber, after this combination the value is decreases. The decrease of OMC is **44.230%.** The dry density values increases **37.03%.**
- It is observed that the unconfined compressive strength of the stabilized expansive soil is increasing with increase in percentage of additives added to the soil. The unconfined compressive strength of stabilized expansive clay is increased by 128.260%, 171.73% &236.95% for 1day, 7days and 14days when treated with Expansive Soil +20% Ground nut Shell Ash+ 1.0% Polypropylene Fiber respectively after that the change of values are nominal.
- The static plate load tests were conducted on untreated and treated expansive soil sub grade foundation beds.
- The laboratory static plate load test results of Expansive Clay. The expansive soil alone has exhibited the ultimate static load of 244.368KN/m^2 with the deformation of 4.11mm at OMC
- Shows The Expansive soil with gravel cushion has exhibited the ultimate static load of 649.659kN/m^2 with the deformation of 2.2 mm at OMC
- The table 5.9 and the Graph 5.9 show the laboratory static plate load test results of Expansive soil. The polypropylene fiber treated expansive soil with Ground nut Shell Ash with gravel cushion has exhibited the ultimate static load of 986.22 kN/m2 with the deformation of 1.25mm at OMC
- The table 5.10 and the Graph 5.10 show the laboratory static plate load test results of Expansive Clay. The polypropylene fiber treated expansive soil with 15% Ground nut Shell Ashwith gravel cushion with geo textile as separator and reinforcement has exhibited the ultimate static load of 1654.6kN/m2 with the deformation of 1.12mm at OMC.
- The load increase from 244.368kN/m2 to 1654.60kN/m2 and settlement decrease to 4.11mm to 1.120mm.

6.2 FURTHER SCOPE OF WORK

The following areas are identified as the scope of further work in this direction, based on the experience of present work.

1. Similar work can be done using other additives and also admixtures to arrive the optimum combination used in construction of foundation beds on expansive soil.
2. The reinforcement Technique can be adopted for higher load bearing capacity of the foundation beds.
3. The technique can also be done with a combination of chemicals like potassium chloride, ferric chloride, calcium chloride and some other fibres etc.
4. Advanced cyclic Tri axial tests may be conducted for further confirmation of test results.

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