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RESEARCH ARTICLE

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STABILIZATION OF SUBGRADE SOIL USING COIR GEOTEXTILE

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ABSTRACT
Soil can be considered as the predominant engineering construction material in the field of Geotechnical Engineering. When we are about to deal with any pavement construction the subgrade soil plays a vital role in all stability aspects. Thus it is quite necessary to determine the stability and strength characteristics of a subgrade soil on which a pavement of layered system is to be constructed. Generally we will face pavement failure problems for a pavement laid over a poor subgrade soil like black cotton soil. Black cotton is a highly expansive soil which emits high swelling and shrinkage nature with variations in natural moisture present in the soil. So there is a great need to stabilize a subgrade soil in order to exhibit good working condition of a pavement. The present paper enhances a study done on the stabilization of black cotton soil using different percentages of coir and geotextile material (glass fibre). In recent times the coir and geotextile fibre applications became very advantageous and can also be used as a soil stabilizer. In this study the performance of subgrade soil is improved by addition of coir and glass fibre to the soil in percentages of 1%, 2%, 3%, 4% and laboratory tests like compaction test(for OMC and MDD values), CBR test were conducted to evaluate the effectiveness of stabilization in the improvement of a subgrade soil.

Keywords: - Black cotton soil, coir, glass fibre, OMC, MDD, CBR.

1. INTRODUCTION

There are many different types of soils, and each one has unique characteristics like colour, texture, structure, and mineral content. The depth of the soil also varies with different types of depositions. Soil is formed slowly as rock (the parent material) erodes into tiny pieces near the Earth's surface. Organic matter decays and mixes with inorganic material such as rock particles, minerals and water to form soil. There are three basic types of soil which is sand, loam or peat soil and also clay or silt particle. Sand is very workable but won't hold water or nutrients well while loam is poor in nutrients, reasonably workable, but hold water well. Clay is difficult to work, compact easily, but holds water and nutrients well, but is reluctant to release these two plants. In engineering construction, the problems with soil always occur even during construction or after construction. This happen as the soil cannot reach the required specification such as the bearing capacity of soil is too weak to support superstructure above it. We can surely suspect these kind of problems in black cotton soil which are widespread about 20% area of the world. When the structure is built on the black cotton soil in the dry seasons, there may be no damage in the pavement in that season. When the rainy season starts, due to the swelling property, the soil get expands and the strength in the foundation structure decreases, which causes uneven settlement leads to cracks

after drying. Due to high degree of expansive soils, the structure may lead to several structural damages. Therefore, the stabilization of soil is important to be applied in the construction of pavements. The main purposes of soil stabilization are to modify the soil, expedite construction and improve the strength and durability of the soil stabilized with additives like coir and glass fibre.

2. Summary from Literature Review

[1]. Usage of Coir Geotextile in construction of pavements can provide cost control and eco-friendly solution for the construction of road by reducing the cost and consumption of other conventional materials to great extent. Coir Geotextile are layered between sub-grade and sub-base layer is becoming an most trending technology. It controls the seepage of water but also brings reduction in pavement thickness. The allowance of seepage water into the sub-grade can be avoided by introducing the geotextile layer or membrane at the interface of Granular Sub-base layer (GSB) and sub-grade which retains the intrusion of sub-grade soil into the interstices of granular sub-base layer, and this leads to proper functioning of Granular Sub-base layer as good drainage layer.

[2]. In this study the conversion of useless construction materials in to useful materials was proposed and it shows that we can use the better ways based on the economic considerations also. Coir fibre is used here as the Reinforcing agent, 3% fibre content required to get CBR value of 6.1%.

[3]. From this paper it is observed that soil that having low natural field density, can be slightly increased. After the treatment of soil with polypropylene fibres' the density is increased gradually to 3%, after 3% the dry density went on decreasing. The OMC of the soil is also decreasing up to 4% and the soil properties are changed due to adding of polypropylene fibers', Bearing capacity of soil is gradually increased and also quarry dust is giving good bearing capacity for Expansive clays. In general bearing ratio (CBR) will be 1.2 to 4, after stabilization the value of CBR reached to 2.5.

[4]. From this paper it is marked that the percentage of Coconut coir fibre added to the soil is taken as 0.25%, 0.50%, 0.75% and 1% and corresponding to each Coconut coir fibre content un-soaked and soaked CBR values are determined from the CBR tests are conducted in the laboratory. From the tests result it is found that for both unsoaked and soaked CBR values of soil increases with the increase in percentage of Coconut coir fibre content. The Soaked CBR values also found to be increased from 3.9 % to 8.6 % and similarly the un-soaked CBR values are also got increased from 8.1 % to 13.2 % of soil mixed with 1% addition Coconut coir fibre. Mixing of coconut coir fibre to soil results in reducing the thickness of pavement due to increase in CBR of mix and reduce the cost of construction and hence the economy of the highway construction will be achieved.

[5]. In the present paper an experimental investigations like Unconfined compression strength (U.C.S) and California bearing ratio (C.B.R) were carried out on the black cotton soil using different percentages of fly ash at 0%, 5%, 10%, 15%, 20% and coconut coir at 0%, 0/25%, 0.5%, 0.75%, 1% to find out the variation of strength of the sub grade. With the addition of 20% of fly ash and 1% of coconut coir the C.B.R value is increased by 285%.

[6]. From this paper it is observed that the physical properties of soil such as hygroscopic moisture content grain size distribution, specific gravity, Atterberg limits, Direct shear test, Swelling pressure, MDD-OMC, CBR, Permeability test values are determined. Various test investigation performed on black cotton soil using different percentages of Fly Ash (FA) at 10%, 15%, 20%, 25%, Coconut Coir Fiber (CCF) at 0.25%, 0.5%, 0.75%, 1% & Crushed Glass (CG) at 3%, 5%, 7% (glass crushed to have gradation of sand size).Addition of Fly

Ash, Coconut Coir Fibre (CCF), and Crushed Glass (CG) in Black Cotton Soil improves the Engineering properties of soil. Present study explains that optimum combination is 20% FA + 5% CG +1 % CCF With soil.

[7]. The Present study gives a brief over the determination of geotechnical properties of soil collected from Chittenahalli and effectiveness of 30% fly ash and coconut fibre (0.25%, 0.5%, 0.75% & 1% by weight of solids) on strength of soil. It is also determined that 30% fly ash and0.50% coconut fibre mix is found to be optimum mix percentage based on strength criteria.

3. EXPERIMENTAL INVESTIGATIONS

Different laboratory procedures confirming to IS: 2720 were conducted on the natural soil and the properties of materials used in this experimental investigations are as follows

A. BLACK COTTON SOIL: For the present study the black cotton was taken from the Veeravasaram village situated near to the Pallakollu mandal, West Godavari district of Andhra Pradesh. The soil is classified as highly expansive soil with good cohesive nature.

Fig 1 : Black cotton soil in the field

Black cotton soil Properties

Table 1: properties of black cotton soil

Soil properties	Results
Grain size Distribution	gravel - 0.6 % sand – 27.4 % fines – 72 %
Specific gravity	2.64
Liquid limit (%)	65
Plastic limit (%)	32
Plasticity Index	23
Free swell index	45
OMC (%)	18.36
MDD (g/cc)	1.662
California Bearing Ratio (CBR) California bearing ratio test	**Unsoaked:** 2.83 % **Soaked:** 1.61 %

B. COIR : The coir geotextile material which is used as a stabilizer was collected from the Kakinada town. The coir got in the form of weaved ropes is teared into pieces of required lengths and blended with soil to proceed laboratory tests

Fig 2 : coir material

Table 2 : properties of coir

Properties	Values
Specific gravity	1.12
Colour	Brown
Diameter	0.1 to 1.5 mm
Length	10 to 20 cm
Density	1.15 – 1.45
Chemical composition	
Lignin	44 %
Hemi cellulose	22%
Cellulose	43%

GLASS FIBER: Glass fibres are the additive which are added to the soil to improve the soil properties. The glass which used was E-Glass type and the fiberglass type was standard chopped strands. The chop length of glass fibres is 13mm and filament diameter are of different sizes ranging from (3µ to 12µ)

Fig : 3 Glass fibre (geotextile material)

Table 3 : Properties of glass fibre

Properties	Values
Colour	Vitreous white
Density	2.58 g/cc
Tensile strength	3445 MPa
Compressive strength	1080 MPa
Thermal expansion	5.4 (µm/m˚C)

4. RESULTS AND DISCUSSIONS

The laboratory tests were conducted on the soil improved with different percentages of stabilizers and the results thus obtained are tabulated to make a further study. The flexibility of subgrade soil is evaluated from the results of CBR test compacted for a density at OMC got from the compaction test. The results obtained are as follows.

Atterberg limits: The liquid limit and plastic limit values of black cotton soil stabilized with coir & geotextile materials cannot be determined as the soil blended with fibrous materials behaves as a non – plastic material because the soil acts a reinforced material.

Compaction test results: From the heavy weight compaction the OMC and MDD values obtained for soil treated with 1%, 2%, 3%, 4% of coir and glass fibre (geotextile material) are as follows

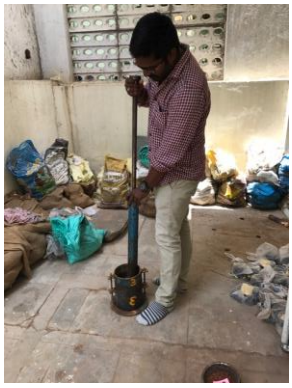

Fig 4: performing heavy compaction

Table 4 : compaction results

Soil added with percentage of coir	OMC (%)	MDD(g/cc)
Soil with 0 % of coir	18	1.662
Soil with 1 % of coir	17.6	1.677
Soil with 2 % of coir	17.15	1.703
Soil with 3 % of coir	18.7	1.675
Soil with 4 % of coir	19.8	1.605

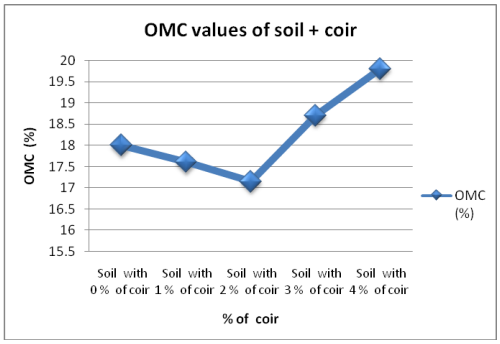

Fig 5 : graph for OMC values of soil treated with coir

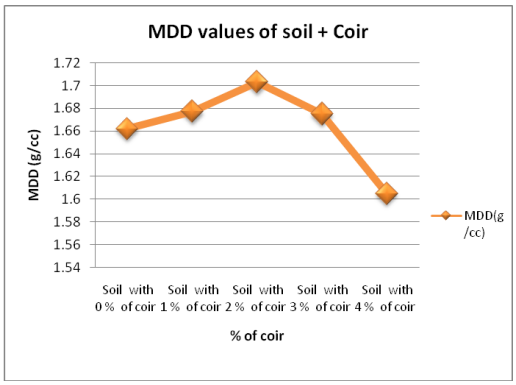

Fig 6 : Graph for MDD values of soil stabilized with coir

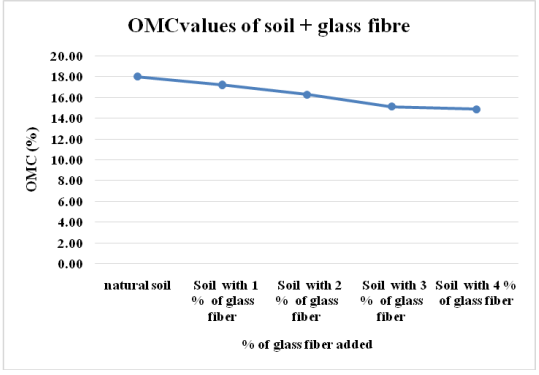

Fig 7 : Graph for OMC values of soil stabilized with Glass fibre

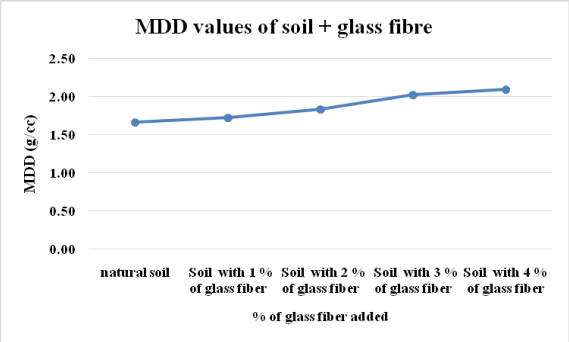

Fig 8 : Graph for MDD values of soil stabilized with Glass fibre

CBR TEST RESULTS

From the CBR test results the CBR values in both unsoaked and soaked condition are tabulated below. The performance of a subgrade can be ultimately evaluated from the CBR test results for the soil stabilized with different percentages of coir fibre.

Fig 9: Performing CBR test in the laboratory

Table 5: CBR unsoaked values with coir

Soil with percentage of coir geotextile	CBR unsoaked 2.5 mm Penetration	CBR Unsoaked 5 mm Penetration
natural soil	2.83	2.24
Soil with 1 % of coir	6.27	4.82
Soil with 2 % of coir	9.54	6.12
Soil with 3 % of coir	9.95	6.36
Soil with 4 % of coir	12.2	8.78

Table 6: CBR unsoaked values with coir

Soil with percentage of coir	**CBR soaked 2.5 mm Penetration**	**CBR soaked 5.0 mm Penetration**
natural soil	1.61	1.18
Soil with 1 % of coir	2.95	1.88
Soil with 2 % of coir	3.55	2.64
Soil with 3 % of coir	4.05	2.97
Soil with 4 % of coir	5.19	3.22

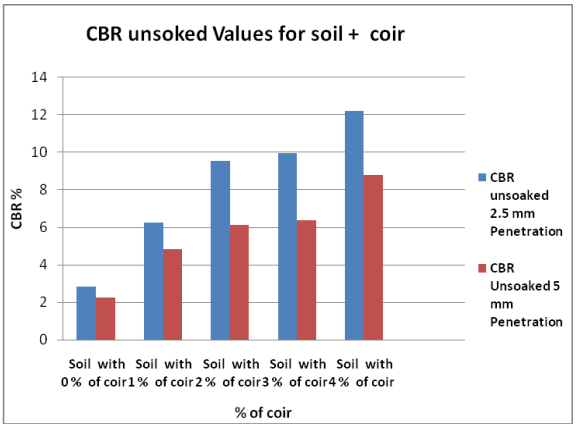

Fig 10: Graph for CBR value in unsoaked condition with coir

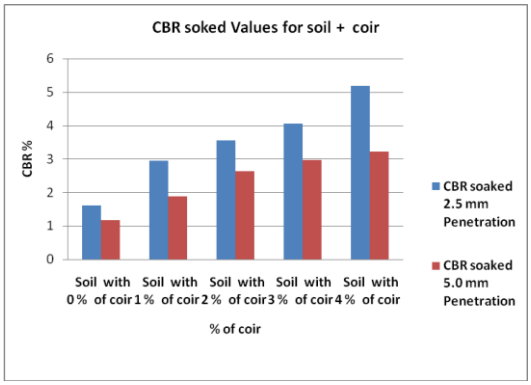

Fig 11: Graph CBR value in soaked condition with coir

Table 7 : final CBR values of soil + coir geotextile

Soilwith percentage of coir	**CBR unsoaked values**	**CBR soaked values**
natural soil	2.83	1.61
Soil with 1 % of coir	6.27	2.95
Soil with 2 % of coir	9.54	3.55
Soil with 3 % of coir	9.95	4.05
Soil with 4 % of coir	12.2	5.19

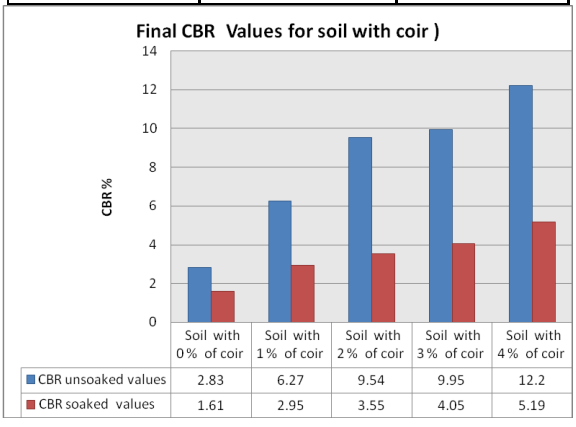

Fig 12 : graph for final CBR values of soil + coir

Table 8: CBR unsoaked values with glass fibre

Soil added with percentage of glass fibre	CBR unsoaked 2.5 mm Penetration	CBR Unsoaked 5 mm Penetration
natural soil	2.83	2.24
Soil with 1 % of glass fiber	3.46	2.84
Soil with 2 % of glass fiber	4.34	3.71
Soil with 3 % of glass fiber	5.67	4.92
Soil with 4 % of glass fiber	5.38	4.65

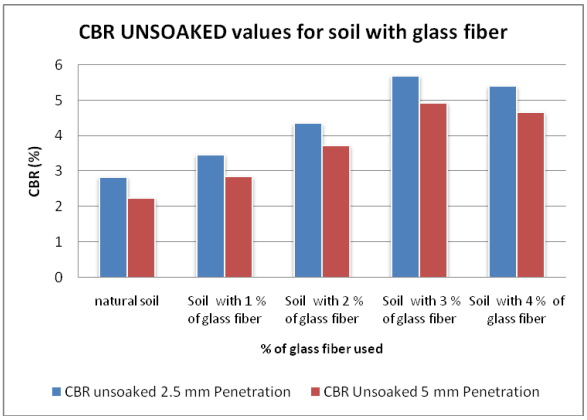

Fig13 : graph for CBR unsoaked values of soil + glass fibre

Table 9: CBR unsoaked values with glass fibre

Soil added with percentage of glass fibre	CBR soaked 2.5 mm Penetration	CBR soaked 5 mm Penetration
natural soil	1.61	1.18
Soil with 1 % of glass fiber	1.89	1.36
Soil with 2 % of glass fiber	2.23	1.59
Soil with 3 % of glass fiber	2.73	1.93
Soil with 4 % of glass fiber	2.63	1.84

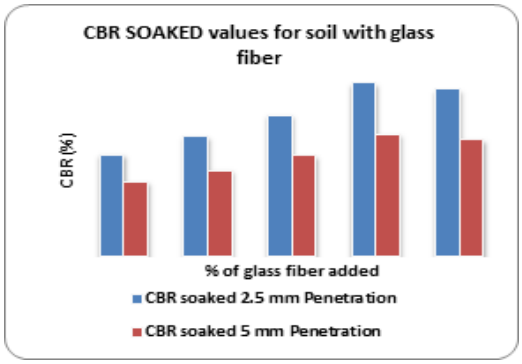

Fig 14 : graph for l CBR soaked values of soil + glass fibre

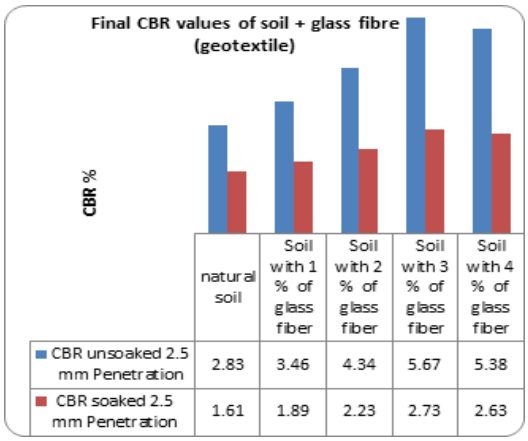

Fig 15 : graph for final CBR values of soil + glass fibre

COMPARISON OF CBR VALUES OF SOIL STABILIZED WITH COIR AND GLASS FIBRE MATERIALS

The final CBR values in both unsoaked and soaked condition for soil stabilized with both stabilizers (coir and glass fibre) individually are compared with results of each and graphs are plotted as follows by taking the maximum values at 2.5 mm penetration.

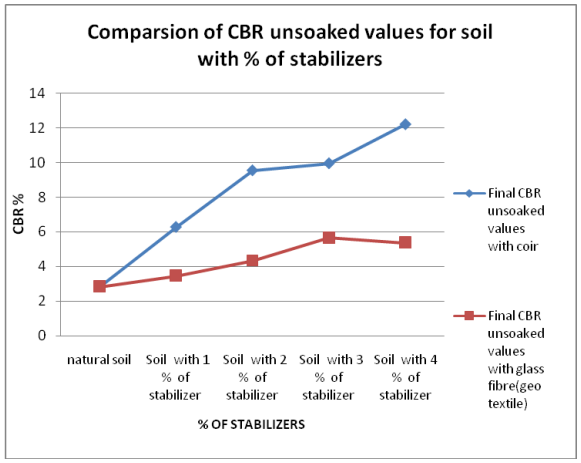

Fig 16 : graph for comparison of CBR unsoaked values of soil with % of stabilizers

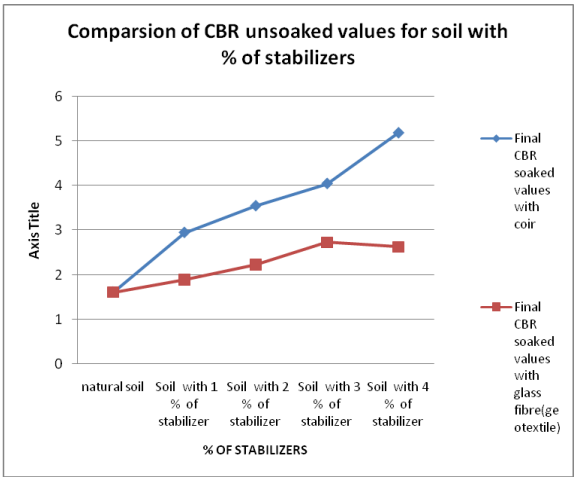

Fig 17 : graph for comparison of CBR soaked values of soil with % of stabilizers

5. CONCLUSIONS

The present thesis elaborates the effectiveness of utilizing the coir geotextile as stabilizer in improving the properties of the black cotton soil used in the subgrade of a pavement. the following conclusions can be made the results obtained from the laboratory tests

1. The OMC values gradually decreased from 18 to 16.8% at 2% of coir addition to the soil and suddenly increased to 19.8 % at 4% of coir addition to natural soil. It is noticed that the maximum dry density of soil in a natural state marked as 1.662 g/cc is increased to 1.721 g/cc for soil stabilized with 2% of coir and there is a drop in MDD value to 1.605 g/cc when the soil is further treated with 4% of coir.
2. With the addition of glass fiber to the soil, the average percentage decrease of OMC was about 3.742% and average increase of MDD percentage with increase of glass fiber was 4.428%
3. The CBR values for both unsoaked and soaked condition are marked as 2.83% and 1.61% for natural soil. There is an appreciable increase in the CBR values with increase in the percentage of coir geotextile. For soil stabilized with coir geotextile the maximum CBR values are observed as 12.20% in unsoaked condition and 5.19% in soaked condition.
4. Similarly with addition of glass fibre the average CBR was increased upto 11.31% in case of unsoaked and 8.92% in case of soaked condition. The maximum increase was seen at 3% addition of glass fiber to the soil.
5. Finally we can conclude that the use of coir and glass fibre geotextile material can be effectively kept in use as a soil stabiliser in improving the subgrade performance to a great extent.

REFERENCES

[1]. Kundan Meshram, S.K. Mittal, P.K. Jain , P.K. Agarwal (October 2013) Application of Coir Geotextile in Rural Roads Construction on BC Soil Subgrade

[2]. K. SWAPNA1, K. GIRIDHAR2 (March-2017) Experimental Investigation of Soil Stabilization by using Coir Fiber, Fly Ash and CaCl2

[3]. Veerubhotla Seshasai1, M.Ramakrishna M.E2, B.V. Sasi Kumar3 (December-2016) Stabilization of expansive soil using fibers

[4]. Shukla Devdatt1, Rajan Shikha2 Saxena A.K.3, Jha A.K.4 (September 2015) Soil Stabilization Using Coconut Coir Fibre

[5]. V Rama Susheel Kumar 1 , J Vikranth 2 (December – 2014) Application of Coconut Coir and Fly ash in Sub grade strengthening

[6]. Amit Tiwari1, H. K. Mahiyar2 (November 2014) Experimental Study on Stabilization of Black Cotton Soil by fly ash, coconut coir fibre and crushed glass

[7]. Sachin.D, Mujeeb2, (October-2016) Effect of Coconut Coir Fibres on Black Cotton Soil Blended with Fly Ash

[8]. A Study On Strength Characteristics of Soil Replaced with Pond Ash and Reinforced with Coir Fibre, (august, 2016) Hima latheef*, asst prof. dipin syam. * civil engineering, jai bharath college of management and engineering Technology, perumbavoor, India

[9]. Geotechnical Engineering text book C. Venkataramaiah, New Age Publications.

[10]. IS Code: 2720 of different parts for laboratory tests of soils. Soil mechanics and foundation Engineering text book

[11]. Soil mechanics and foundation Engineering text book, Dr. K.R. Arora, Standard Publisher Distributors

[12]. Mostafa Deep Hashem, Afaf Abdel Haleem Mahmoud, Ahmed Moussa Abu Bakr, Ahmed Awad Hag 4 (March 2016) ,Stabilization of expansive Subgrade soil by using additives.