AN EXPERIMENTAL STUDY ON SOIL STABILIZATION BY ADDITION OF BIO-ENZYME

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ABSTRACT

The important factor for design and construction of any structure is the behavior of soil. As the soil is weak the bearing capacity is also low. So in this present study provides an effective technique for soil stabilization by using BIO-ENZYMES and GEO- TEXTILES. In this study bio-enzymes is used as an admixture and geo-textiles are used as reinforcement in the soil. This investigation is carried for two different types of soil from two different areas. Soil is always responding to changes in environmental factors, along with the influences of man and land use. Some changes in the soil will be of short duration and reversible, others will be a permanent feature of soil development.This paper deals with both index and engineering properties for the improvement of soil stabilization and soil strength. We are carrying CALIFORNIA BEARING RATIO [CBR], “OMC” and PERMEABILITY tests.

Keywords: B*io-enzymes, Geo- textiles , Permeability tests, California Bearing Ratio,*

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1. INTRODUCTION

Soil is any uncemented accumulation of mineral particles formed by weathering of rocks. Soils are generally used as foundation or as construction materials. A class of soil, known as expansive soils, when used as foundation material, is usually affected by environmental conditions and climatic conditions.

These soils cause more damage to structures, particularly light building and pavements, than any other natural hazards, including earthquakes and floods. Stabilization of the soil with admixtures is a common method of reducing the swell. Consequently, recent researches have focused on the use of locally available materials to achieve more economic stabilization of the soil.

IMPORTANCE OF SOIL :

Soil is a vital part of the natural environment. It is just as important as plants, animals, rocks, landforms, lochs and rivers. It influences the distribution of plant species and provides a habitat for a wide range of organisms. It controls the flow of water and chemical substances between the atmosphere and the earth, and acts as both a source and store for gases (like oxygen and carbon dioxide) in the atmosphere. Soils not only reflect natural processes but also record human activities both at present and in the past. They are therefore part of our cultural heritage. The modification of soils for agriculture and the burial of archaeological remains are good examples of this Soil, together with the plant and animal life it supports, the rock on which it develops, its position in the landscape and the climate it experiences, form an amazingly intricate natural system – more powerful and complex than any machine that man has created. Soil may look still and lifeless, but this impression couldn't be further from the truth. It is constantly changing and developing through time. Soil is always responding to changes in environmental factors, along with the influences of man and land use. Some changes in the soil will be of short duration and reversible, others will be a permanent feature of soil development.

DIFFERENT TYPES OF SOIL :

The ground on which we walk is never quite the same, it keeps on changing. Sometimes it is made up of millions of tiny granules and other times it is the hard surface of tar covered roads. There was the time long back when this ground was mostly covered with soil and grass. And then came the roads, rails and so on.

There are three stages of soil: solid soil, soil with air in the pores and soil with water in the pores. Due to the number of different forms of organic and mineral compositions in the soil, there are various types of soil that undergo different environmental pressures.

The soil is basically classified into three types:

- Sand
- Silt
- Clay
- Loam

Fig: 1.1 Different types of soils

SAND: The first type of soil is the sand. It consists of small particles ofweathered rock. Sandy soils are one of the poorest types of soils to grown any kind of plants because it stops the soil from retaining water and makes it hard for the plants roots to absorb water. But this type of soil plays a very good role in the drainage system.

SILT: Silt, which is known to have much smaller particles compared to thesandy soil and is made up of rock and other mineral particles which are smaller than sand and larger than clay. It is the smooth and quite fine quality of the soil that holds water better than sand. Silt is easily transported by moving currents and it is mainly found near the river, lake beds, etc. The slit is more fertile soil compared to other three types of soil. Therefore it is also used in agricultural practices to improve soil fertility.

Fig: 1.2 Silt

CLAY: Clay is the smallest particles amongst other two types of soil. Theparticles in this soil are tightly packed together with each other with very little or no airspace. This soil has a very good water storage qualities and making hard for moisture and air to penetrate it. It is very sticky to the touchwhen wet, but smooth when dried. Clay is the densest and heaviest types of soils which do not drainswell or provide space for plant roots to flourish.

LOAM: Loam is the fourth types of soil. Even though it is a combination ofsand, silt, clay. It is the gardener's favorite kind of soil. Among all these three types of soil, this loamy soil is more suitable for farming. Loam soil is also referred to as an agriculture soil as it includes equilibrium of all three types of soil materials being sand, clay and silt and also happens to have humus. Apart from these, it also has a higher calcium and pH levels because of its previous organic material content.

Fig: 1.3 Loam

MATERIALS COLLECTED:

Soil Sample 1 is collected from **KOVVADA** and Sample 2 is collected from **KALINGAPATNAM.**

The following admixtures and reinforcement are used for this study

- Bio-enzyme
- Geo-textile (size 5X10mm)

BIO ENZYME :

Growth promoters are also available for soil application in granules and soil forms. Bio enzyme granules is an eco friendly soil application supplement which contains growth stimulants made from vegetables It granules helps for uniform growth of products, Better Yield, makes plants able to withstand stress and drought conditions and also helps in increased production, reduced fruits, flower dropping and develops resistance against pests and diseases.

DETERMINATION OF CALIFORNIA BEARING RATIO (CBR) :

It is the ratio of force per unit area required to penetrate a soil mass with a standard circular piston of 1875 mm, cross sectional area at the rate of 1.25mm per min. to that required sample of compacted stone which is defined as having a CBR of 100%. The standard load (ps) corresponding to 2.5mm penetration of the plunger in to the standard sample is reported to the 1370kgs and 5mm penetration it was found to be 2055kgs. California bearing ratio values are useful in estimating the thickness of flexible pavements and strength of soils.

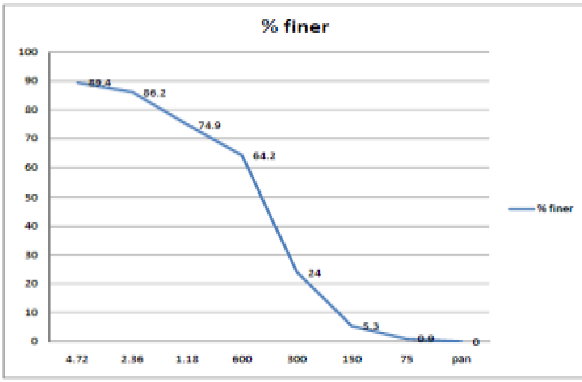
SIEVE ANALYSIS FOR SOIL SAMPLE :

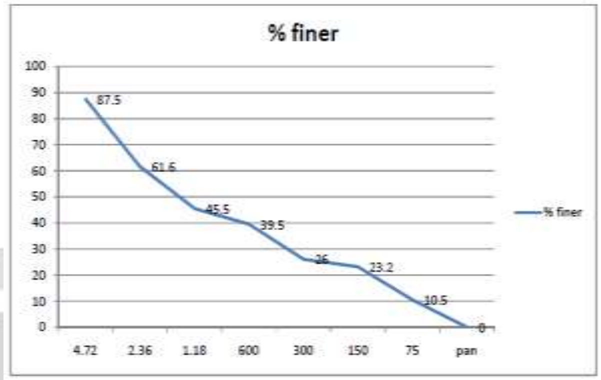
Table 1 Sieve Analyses for Kovvada Soil

Sieve size	Sieve wt (w_1)	Sieve + soil (w_2)	Soil retained (w_3)	% Soil retained	Cumulative %	% Finer
4.72	388	494	106	10.6	10.6	89.4
2.36	334	366	32	3.2	13.8	86.2
1.18	328	441	113	11.3	25.1	74.9
600	344	431	107	10.7	35.8	64.2
300	321	723	402	40.2	94.7	24
150	326	513	187	18.7	99.1	5.3
75	309	353	44	4.4	94.7	0.9
pan	261	270	9	0.9	100	0

Table 2 Sieve Analyses for Kalingapatnam Soil

Sieve size	Sieve wt (w_1)	Sieve + soil (w_2)	Soil retained (w_3)	% Soil retained	Cumulative %	%Finer
4.72	388	413	125	12.5	12.5	87.5
2.36	334	593	259	25.9	38.4	61.6
1.18	328	418	161	16.1	54.5	45.5
600	344	404	60	6.0	60.5	39.5
300	321	426	135	13.5	74	26
150	326	356	28	2.8	76.8	23.2
75	309	320	127	12.7	89.5	10.5
pan	261	366	105	10.5	100	0

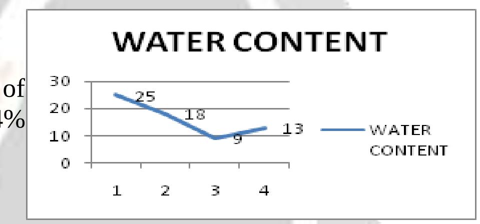




Sieve Analysis for Soil Sample 1(Kovvada)
From below graph we observe that
Cu = D60/D10 = 2.94 , Cc = (D30)2/ (D60 X D10) =1.20

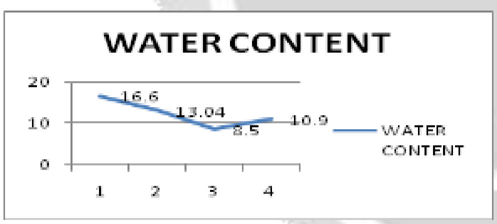
Sieve Analysis for sample2 (kalingapatnam)
From below graph we observe that
Cu = D60/D10 = 3.01 ,Cc =0.021

1(KOVVADA)
Graph: 4.8 Water content for Kovvada soil



From the graphs 4.7 and 4.8, it is observed that the water content of kovvada soil with bio-enzyme gradually decreases from 1% to 4% when compared with soil with zero-percentage of bio-enzyme.

COMPACTION VALUES FOR SAMPLE2 WITHOUT BIO-ENZYME:



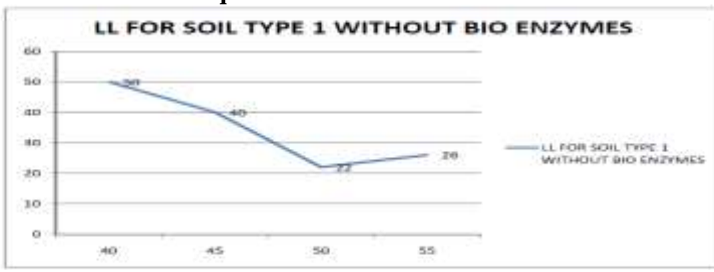
Elements	0%	4%	6%	8%	10%	12%
Volume of mould (V)	9817	9817	9817	9817	9817	9817
Wt of mould (w_1)	7722	7722	7722	7722	7722	7722
Mould + soil (w_2)	9094	9261	9319	9342	9409	9318
Wt of soil (w_3)	1372	1539	1417	1620	1687	1596
Υ_b = m/v	0.13	0.15	0.14	0.16	0.17	0.16
$\Upsilon_d = (\Upsilon_b / 1 + w\ \%)$	0.012	0.013	0.012	0.010	0.014	0.014

Table 3 Compaction Values For Kalingapatnam Soil

Liquid Limits for Kovvada Soil :

S.no	Water added (%)	No of blows	Water content present in soil (w %)
1	18	50	45
2	19	40	47.5
3	20	22	50
4	22	26	55

Table 4 Liquid Limits for Kovvada Soil

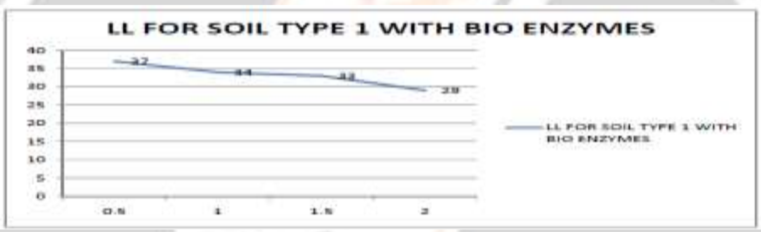


Liquid Limits for Soil Sample 1 without Bio-Enzyme (Kovvada)

LIQUID LIMIT FOR SAMPLE1 WITH BIO-ENZYME

S. no	Water Content (%)	% Bio Enzyme
1	37	1
2	34	1.5
3	33	2
4	29	2.5

Table 5 Liquid Limit For Kovvada Soil With Bio-Enzyme

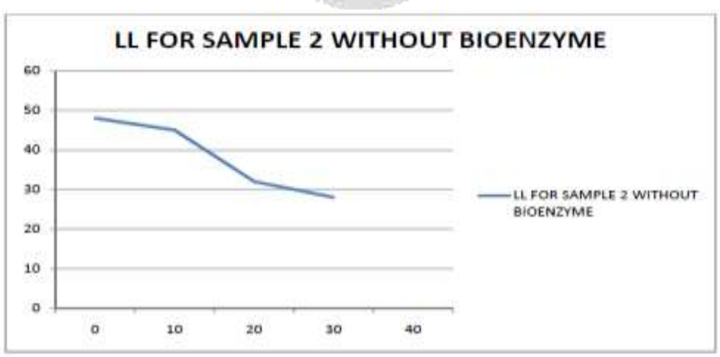


From the above both graphs , it is observed that Liquid limit of Kovvada soil with Bio-enzyme gradually decreases from 1% to 2.5% when compared with soil with zero percentage of bio-enzyme

Liquid Limit For Kalingapatnam Soil :

S. no	Water added (%)	No of blows	Water content present in soil (w %)
1	18	48	32.5
2	19	45	37
3	20	32	39.7
4	22	28	45

Table 6 Liquid Limit For Kalingapatnam Soil

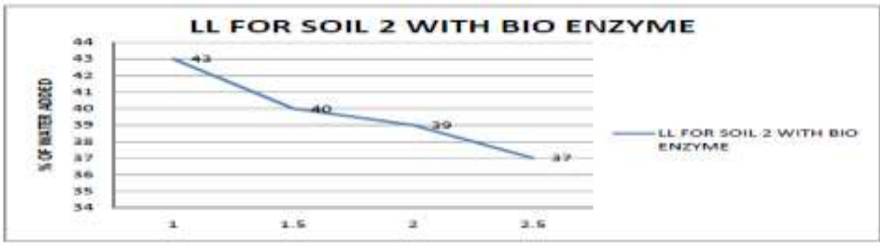


Liquid Limit for Soil Sample 2 without Bio-Enzyme (Kalingapatnam)

LIQUID LIMIT FOR SAMPLE2 WITH BIOENZYME (kalingapatnam):

Sl No	% Of Bio Enzyme	Water Added (%)
1	1	43
2	1.5	40
3	2	39
4	2.5	37

Table 7 Liquid limit for sample2



Liquid Limit for Soil Sample 2 with Bio-Enzyme (Kalingapatnam)

DESCRIPTION OF GRAPH:

From the graphs, it is observed that Liquid limit of Kalingapatnam soil with Bioenzyme gradually decreases from 1% to 2.5% when compared with soil with zero percentage of bio-enzyme.

Table 8 PLASTIC LIMITS: PLASTIC LIMIT FOR SAMPLE1 WITH OUT BIO- ENZYME

Sl no	Water added (%)	Weight of can	Wet soil + can weight	Dry soil + can weight	Water %
1	18	20	23	22	50%
2	19	19	21.1	20.1	90%
3	20	12	15.4	14	70%
4	22	16	20.8	14	60%

Table 9 PLASTIC LIMIT FOR SAMPLE1 WITH BIO-ENZYME

Sl no	Water added in %	Weight of can	Wet soil + can weight	Dry soil + can weight	Water %
1	22%	0.021	0.024	0.023	50%

Table 10 PLASTIC LIMIT FOR SAMPLE2 WITH OUT BIO-ENZYME (KALINGAPATNAM)

Sl no	Water added in %	Weight of can	Wet soil + can weight	Dry soil + can weight	Water %
1	18	20	45	40.5	21%
2	19	19	32	29.5	33%
3	20	12	30.2	28.5	10%
4	22	16	29	25	44%

Table 11 PLASTIC LIMIT FOR SAMPLE2 WITH BIO-ENZYME

Sl no	Water added in %	Weight of can	Wet soil + can weight	Dry soil + can weight	Water %
1	22%	0.021	0.024	0.023	50%

PERMEABILITY OF SOIL:

Permeability is a measure of the ease in which water can flow through a soil volume.

Permeability constant (k) = **QL/Aht** Where Q = quantity, L = length of the mould , A = area of the mould, H = constant head , T = time in secants

Table 12 Permeability values for Kovvada soil (Unmodified Soil)

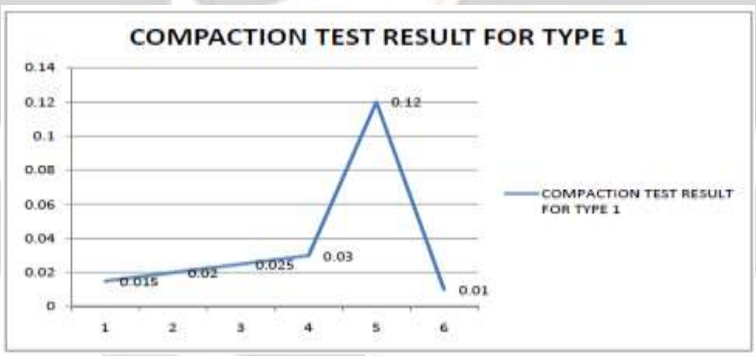
S. No	Constant Head (H)	Quality(Q)	Time(T)	Constant of permeability (K) (Cm/sec)
1	90	0.5	60	$1.49X10^{-4}$
2	90	1.0	120	$1.49X10^{-4}$
3	90	1.2	180	$1.19X10^{-4}$
4	90	1.9	240	$1.42X10^{-4}$
5	90	2.5	300	$1.49X10^{-4}$
		AVG		$1.41X10^{-4}$

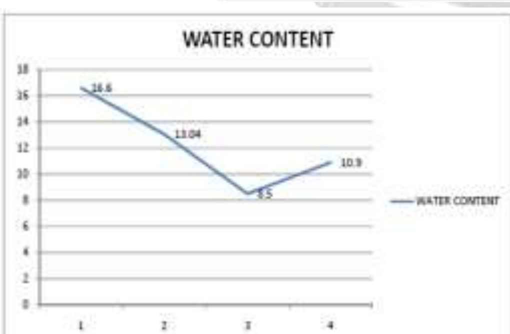
Table 13 Permeability values for Kalingapatnam soil (Unmodified Soil)

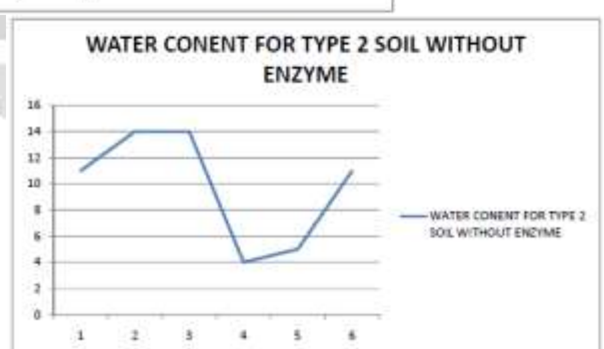
S. No	Constant Head (H)	Quality(Q)	Time(T)	Constant of permeability (K) (Cm/sec)
1	90	0.3	60	$0.89 X 10^{-4}$
2	90	0.4	120	$0.59 X 10^{-4}$
3	90	0.5	180	$0.49 X 10^{-4}$
4	90	0.8	240	$0.59 X 10^{-4}$
5	90	1.0	300	$0.59 X 10^{-4}$
		AVG		$0.63 X 10^{-4}$

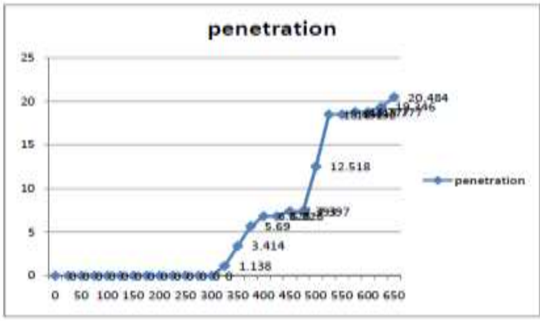
COMPACTION TEST:

COMPACTION VALUES FOR SAMPLE1 WITHOUT BIO- ENZYME:

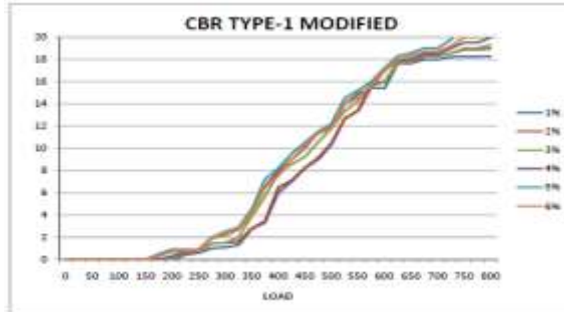








CBR for Kovvada soil of Unmodified



CBR for Kovvada soil modified

CBR 2.5 Modified Soil values (adding geo-textile and bio-enzyme):

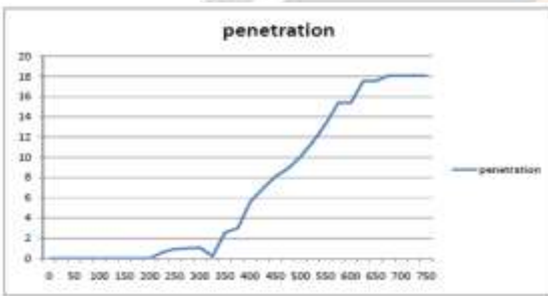
1% BIOENZYME, CBR 2.5 = 2.18

2% BIOENZYME, CBR2.5 =2.84

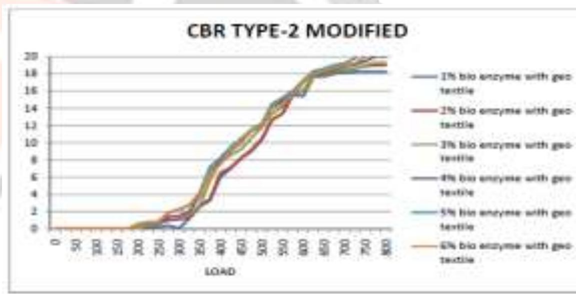
3% BIOENZYME, CBR2.5 =2.99

4% BIOENZYME, CBR2.5 =6.93

5% BIOENZYME, CBR2.5 =6.71



CBR for kalingapatnam Soil of Unmodified



CBR for Kalingapatnam soil of modified

For the above working, it is clear show that 5% of bio-enzyme is suitable for the kalingapatnam area soil when compared with unmodified soil.

CBR 2.5 Modified Soil values (adding geo-textile and bio-enzyme)

1% Bio enzyme, CBR2.5 = 3.06

2% Bio enzyme, CBR2.5 = 3.94

3% Bio enzyme, CBR2.5 = 4.81

4% Bio enzyme, CBR2.5 = 5.25

5% Bio enzyme, CBR2.5 = 6.49

6% Bio enzyme, CBR2.5 = 5.91

CONCLUSIONS :

From the above observations and test result we have obtained the following results for Kovvada soil sample and Kalingapatnam soil sample individually.

- By conducting sieve analysis both the samples are poorly graded
- It observed that specific gravity of kovvada soil is peat & kalingapatnam soil is silt clays.
- By adding bio enzyme the consistence limits gradually decreased
- By adding bio-enzyme for Kovvada soil sample and Kalingapatnam soil sample at 4% of bio-enzyme the water content decreased when compared to un modified soil individually.
- By adding bio-enzyme and placing geo-textile the CBR value increases at 4% of bio enzyme for Kovvada soil sample and 5% of bio-enzyme for kalingapatnam soil sample.

● It is observed at that the discharge of water is also decreased due to adding of bio-enzyme to both samples individually.

REFERENCES

1. G. V. Rama Rao, P. Hanuma, An Experimental Study on Stabilization of Soils by Using Bio-Enzymes, (IJTSRD) Volume 3 Issue 5, August 2019.

2. Sandeep Panchal, Md. Mohsin Khan , Anurag Sharma, STABILIZATION OF SOIL USING BIO-ENZYME, IJCIET, Volume 8, Issue 1, January 2017, pp. 234–237,

3. Ashish Mehta, Kanak Parate, Ruprai B.S, "Stabilization of black cotton soil by fly ash", in IJAIEM, (2013), ISSN: 2319-4847.

4. Omer Nawaf Maaitah Soil Stabilization By Chemical Agent, Geotechnical And Geological Engineering, 2012, Pp.1345-1356

5. N.K.Sharma,S.K.Swain,Umesh C. Sahoo Stabilization Of Clayey Soil With Fly ash And Lime: A Micro Level Investigations : Geotechnical And Geological Engineering,2012,Pp.1197-1205.

6. Pankaj R. Modak, Prakash B. Nangare, Sanjay D. Nagrale, Ravindra D. Nalawade, Vivek S. Chavhan, "Stabilisation of Black Cotton Soil Using Admixtures", in IJEIT, Volume 1, Issue 5, May 2012, 1-3.

7. M.A. Ansary, M.A.Noor, M.Alam Effect of Flyash Stabilization on Geotechnical Properties Of Chittagong Soil. Geotechnical Symposium in Roma, 2006, Pp. 443-454.

8. Jose leitaoborges "overall stability of geo-synthetic-reinforced embankments on soft soils" in geo-textiles and geo-membranes, 2002, volume 20, issue 6.

9. Stability of embankments" in geo-textile s and geomembranes, 2002, volume 20, issue 6.

10. M.Sugimoto.A.M.N.Alagiyawanna, K.Kadoguchi "influence of rigid and flexible face on geogrid pullout tests" in geo-textile s and geomembranes, 2001, volume 19, issue 5.

11. S.M.B.Helwany, G.Reardon,J.T.H.Wu "effects of backfill on the performance of GRS retaining walls" in geo-textile s and geomembranes,1999,volume 17, issue 1.

12. Mark. W. Cadwallader, "Addressing the special concerns of landfill closure VLDPE and textured geomembranes" in geo-textiles and geomembranes, 1991, volume 10,issue 5-6

13. Ronald K. Frobel, Richard t.taylor, "CSPE/geo-textile geocomposites" in geo-textiles and geomembranes, 1991, volume 10, issue 5-6.

14. Robert G. Carroll jr, vickey chovery-curtis, "geogrid reinforcement in landfill Closures" in geo-textile s and geomembranes, 1991, volume 10, issue 5-6

IS CODES

15. IS 2720: Part 3: 1980 Methods of Test for Soils: Determination of Specific gravity.
16. IS 2720: Part 4: 1975 Methods of Test for Soils: Grain size analysis
17. IS 2720: Part 5: 1985 Methods of Test for Soils: Determination of Liquid and Plastic limit.
18. IS 2720: Part 7: 1965 Methods of Test for Soils: Determination of water Content and dry density relation using Light Compaction.
19. IS 2720: Part 16: 1969 Methods of Test for Soil: Laboratory Determination of CBR.
20. IS 2720: Part 17:1966 Methods of Test for Soil: Laboratory Determination of Permeability