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Investigation for the Improvement of Soil Stabilization

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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.

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.

1.1 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.

1.2 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

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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.

Fig: 1.1 Different types of soils

The soil is basically classified into three types:

- Sand
- Silt
- Clay
- Loam

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: 1.3 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: 1.5 Loam

1.3 SOIL PERFORMANCE

A sub grade's performance generally depends on two interrelated characteristics.

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LITERATURE REVIEW

2.1NEED FOR SOIL IMPROVEMENT

Improvement refers to alternation of any property of soil to improve the engineering performance. When the soil cannot support load, the soil can be modified with the aid of a definite process to suit the requirement. The technique involved is the attainment of the required improvement facilities is referred to as a geotechnical process. The need for improvement arises based up on the existing soil conditions as well as the traffic conditions along with the other external factors like geography, atmosphere, seasonal variations, etc.

2.1.1 POOR GROUND CONDITIONS:

Poor ground conditions depends upon local condition include in geological conditions, which may require special treatment for development. A few examples for poor ground conditions are,

- Expansive soils
- Soft soils with low bearing capacity
- Highly compressible organic soils
- Loose sand and silt

2.2FACTORS TO BE CONSIDERED FOR SELECTION OF AN IMPROVEMENT TECHNIQUE:

Factors to be considered for selection of an improvement technique in any case may include:

- Soil type- grave, silt & clay
- Area and depth of treatment required
- Type of structure and load distribution
- Soil properties- strength, compressibility & permeability etc
- Materials available- stone, water, admixtures & stabilizers
- Availability of equipment
- Environmental conditions- disposal waste, erosion, water pollution etc
- Economy

2.3METHODS OF IMPROVEMENT:

The following methods are currently in practice for improving week soil properties namely.

- Densification of soil with compaction
- Stabilization of soil

2.3.1 DENSIFICATION OF SOIL WITH COMPACTION:

Compaction is the process of densification with the reduction in volume by expulsion of air through application of compactive effort. Densification is reduction of air voids may occur in number of ways such as reorientation of particles, fracture of grains or the bonds between them followed by reorientation and bending or distortion of the particles and their absorbed layers. In a cohesive soil the densification is attained by distortion and reorientation which are resisted by inter particles forces. In a cohesion less soils are Coarse grained soils, the densification is usually accomplished by reorientation of grains which is resisted by friction between the particles dependent creep properties.

The model is compared to a series of uni -axial tension tests performed on a biaxial geo-grid and a woven geo-textile. Tension tests to which model predictions are compared include fast and slow monotonic tension, constant load creep tests and two series of cyclic tension. The model is shown to offer reasonable predictions of in-air tensile load– strain properties commonly associated with geo-synthetic materials

5. G. Carroll et al. [1991]: The author described about the use of geo-grids inlandfill the design consideration of long-term allowable strength of geo-grids is also addressed. Factors such as geo-gridcreep,installationdamage,.

EXPERIMENTAL STUDY:

Experimental studies for determination of index and engineering properties on two different soils are carried out from two different areas. The engineering properties are determined on soil samples in lab. One type of admixture is used for this study. The details of materials used their properties and details of engineering properties determined in lab presented below.

- Materials collected

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- Parameters studied

3.1.1MATERIALS 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)

SOIL TYPES:

RED SOIL

The soil used for the present study is collected locally from a location is nearer to kovvada village in Srikakulam district. The soil was collected at a depth of approximately 1.0m from the existing road level.

BLACK COTTON SOIL

The soil used for the present study is collected locally from a location is nearer to kalingapatnam village in Srikakulam district. The soil was collected at a depth of approximately 1.0m from the existing road level. Disturbed sample is used for experimental work.

Fig: 3.11 Type 2 soil

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.

Fig: 3.12 Bio-enzyme

3.2PARAMETERS STUDIED:

The following parameters are determined in experimental work.

- Index & engineering properties of modified and unmodified soil
- Optimum moisture content (OMC) and maximum dry density (MDD) of modified and unmodified soil.

3.3DETERMINATION OF INDEX PROPERTIES:

1. Grain size distribution
2. Atterberg's limits
3. Specific gravity

3.3.1 DETERMINATION OF GRAIN SIZE DISTRIBUTION (IS 2720-part 4 – 1975):

This test is performed to determine the percentage of different grain sizes contained within a soil. The mechanical or sieve analysis is performed to determine the distribution of the coarser, larger-sized particles, and the hydrometer method is used to determine the distribution of the finer particles.

Fig: 3.14 Mechanical shaker

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3.3.2ATTERBERG'S LIMITS: (IS 2720 PART 5 – 1985):

This lab is performed to determine the plastic and liquid limits of a fine-grained soil. The liquid limit (LL) is arbitrarily defined as the water content, in percent, at which a part of soil in a standard cup and cut by a groove of standard dimensions will flow together at the base of the groove for a distance of 13 mm (1/2 in.) when subjected to 25 blows from the cup being dropped 10 mm in a standard liquid limit apparatus operated at a rate of two shocks per second. The plastic limit (PL) is the water content, in percent, at which a soil can no longer deformed by rolling into 3.2 mm (1/8 in.) diameter threads without crumbling.

Fig: 3.15 Liquid limit

3.3.3 DETERMINATION OF SPECIFIC GRAVITY: (IS 2720- PART 3-1980):

This lab is performed to determine the specific gravity of soil by using a pycnometer. Specific gravity is the ratio of the mass of unit volume of soil at a stated temperature to the mass of the same volume of gas-free distilled water at a stated temperature. The specific gravity of a soil is used in the phase relationship of air, water, and solids in a given volume of the soil.

Fig: 3.17 Specific gravity

3.4DETERMINATION OF ENGINEERING PROPERTIES:

3.4.1 DETERMINATION OF OPTIMUM MOISTURE CONTENT (OMC) AND MAXIMUM DRY DENSITY (MDD) (IS 2720-Part 7-1980):

This laboratory test is performed to determine the relationship between the moisture content and the dry density of a soil for a specified compactive effort. The compactive effort is the amount of mechanical energy that is applied to the soil mass. Several different methods are used to compact soil in the field, and some examples include tamping, kneading, vibration, and static load compaction. Therefore, the test is also known as the Proctor test. There are two types of compaction tests are routinely performed

- Standard proctor test
- Modified proctor test

3.4.2 DETERMINATION OF PERMEABILITY (IS 2720 Part-17-1966):

Permeability is a measure of the ease in which water can flow through a soil volume. It is one of the most important geotechnical parameters. However, it is probably the most difficult parameter to determine. In large part, it controls the strength and deformation behavior of soils

The main Application is estimation of quantity of underground seepage water under various hydraulic conditions. Quantification of water during pumping for underground construction. The stability analysis of slopes, earth dams and earth retaing structures. Design of land fills liner.

Fig: 3.19 Permeability

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3.4.3 DETERMINATION OF CALIFORNIA BEARING RATIO (CBR) (IS 2720 Part-16-1969):

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.

Fig: 3.20 CBR Testing

PRESENTATION OF RESULTS AND DISCUSSIONS

4.1SIEVE ANALYSIS

4.1.1 SIEVE ANALYSIS FOR SOIL SAMPLE 1(KOVVADA)

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	451	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

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	266	105	10.5	100	0

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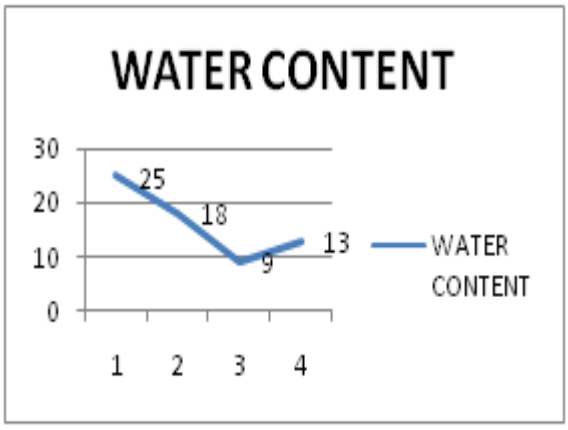


Graph: 4.8 Water content for Kovvada soil

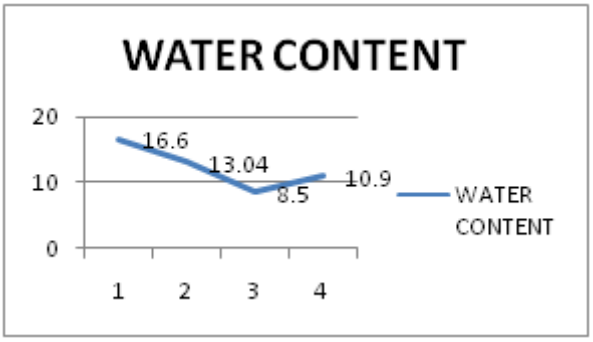
DESCRIPTION OF GRAPH:

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.

4.4.3 COMPACTION VALUES FOR SAMPLE2 WITHOUT BIO-ENZYME:

Table 4.16 Compaction Values ForKalingapatnam Soil

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



Graph: 4.10 Water content for Kalingapatnam soil

DESCRIPTION OF GRAPH

From the graphs 4.9 and 4.10, it is observed that the water content of kalingapatnam soil with bio-enzyme gradually decreases from 1% to 4% when compared with soil with decreases zero-percentage of bio-enzyme.

4.5PERMEABILITY 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

4.6CALIFORNIA BEARING RATIO

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.

STANDERS LOADES WITH PENETRATIONS

Penetration In Mm	Standard Load
2.5	1370
5.0	2055
7.5	2630
10.0	3180
12.5	3600

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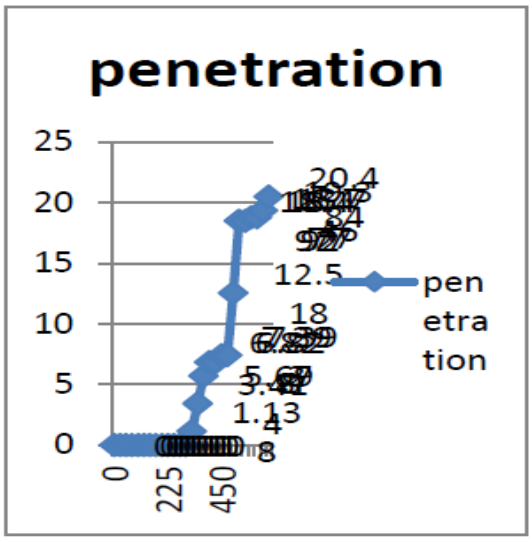
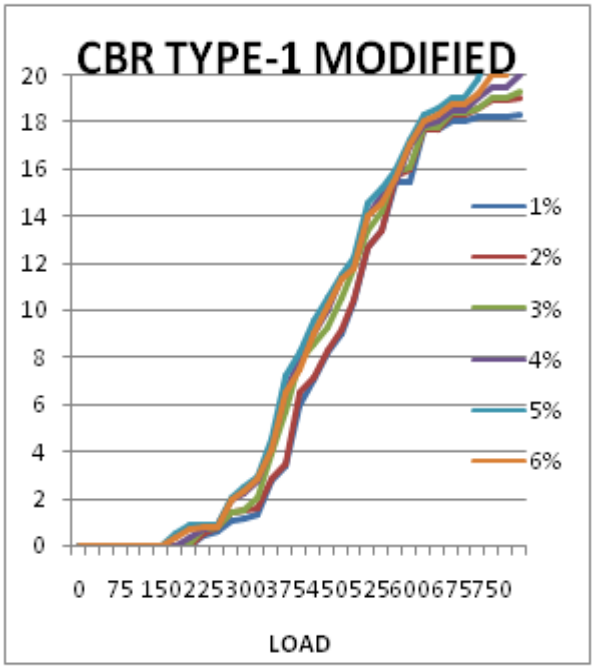


4.6.2CBR TEST RESULT FOR MODIFIED SOIL SAMPLE



Graph: 4.12 CBR for Kovvada soil of Modified

CBR $_{2.5}$ Modified Soil values (adding geo-textile and bio-enzyme):

1% BIOENZYME, CBR $_{2.5}$ = 2.18

2% BIOENZYME, CBR$_{2.5}$ =2.84

3% BIOENZYME, CBR$_{2.5}$ =2.99

4% BIOENZYME, CBR$_{2.5}$ =6.93

5% BIOENZYME, CBR$_{2.5}$ =6.71

DESCRIPTION OF GRAPHS

For the above working, it is clear show that 4% of bio-enzyme is suitable for the kovvada area soil when compared with unmodified soil.

4.6.3CBR TEST RESULT FOR UN MODIFIED SOIL

Table 4.27 CBR values for Kalingapatnam Soil (Unmodified Soil)

S.no	Penetration in dial gauge	Penetration in mm	Proving ring readings	Load = proving ring readings X 5.69
1	0	0	0	0
2	25	0.25	0	0
3	50	0.50	0	0
4	75	0.75	0	0
5	100	1.00	0	0
6	125	1.25	0	0
7	150	1.50	0	0
8	175	1.75	0	0
9	200	2.00	0	0
10	225	2.25	0.10	0.6
11	250	2.50	0.16	0.94
12	275	2.75	0.17	0.99
13	300	3.00	0.18	1.07
14	325	3.25	0.21	0.22
15	350	3.50	0.44	2.56
16	375	3.75	0.52	3.01
17	400	4.00	0.98	5.59
18	425	4.25	1.21	6.92
19	450	4.50	1.42	8.11
20	475	4.75	1.56	8.88
21	500	5.00	1.76	10.07
22	525	5.25	2.03	11.56
23	550	5.50	2.33	13.29
24	575	5.75	2.70	15.39
25	600	6.00	2.70	15.39
26	625	6.25	3.08	17.54
27	650	6.50	3.08	17.54
28	675	6.75	3.17	18.09
29	700	7.00	3.17	18.09
30	725	7.25	3.17	18.09
31	750	7.50	3.17	18.09

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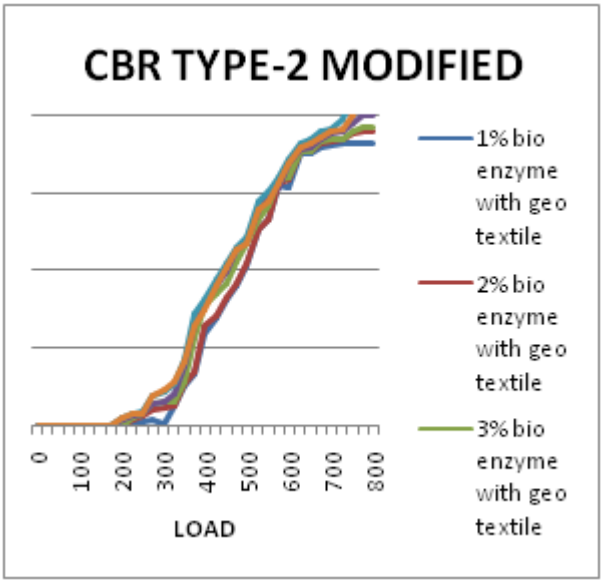

Graph: 4.14 CBR for Kalingapatnam soil of modified

DESCRIPTION OF GRAPHS

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, $CBR_{2.5}$ = 3.06
2% Bio enzyme, $CBR_{2.5}$ = 3.94
3% Bio enzyme, $CBR_{2.5}$ = 4.81
4% Bio enzyme, $CBR_{2.5}$ = 5.25
5% Bio enzyme, $CBR_{2.5}$ = 6.49
6% Bio enzyme, $CBR_{2.5}$ = 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.

SCOPE FOR FURTHER WORK

- Here we are use bio-enzyme has admixture and woven geo-textile but we can use other type of geo-textile and admixture also.
- Further project can be continued by finding the direct shear test, vane shear test and flexile test in all conditions.
- A study can be taken up with other types of admixtures and comparison can be done among the admixtures for maximum strength property.

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