PERFORMANCE AND EVALUATION STUDY ON PAVEMENT SUB GRADE THICKNESS BY USING BIO-ENZYME AND DIFFERENT ADD MIXTURES

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ABSTRACT: Research on soil stabilization by enzymes though started more than two decades ago, very little research has been done on simulating field conditions for the laboratory studies on behaviour of enzyme treated soils. Road construction on soils with poor engineering properties necessitates adoption of Stabilization techniques. Bio-enzymes are found to improve the soil properties and thus performance of roads. Effect of bio-enzymes on soils depends on type, dosage of bio-enzyme, its curing period and amount of fines. To evaluate the effect of bio-enzyme, the soil was treated with varying dosages of Bio-enzyme, a commercial Bio-enzyme and the effect of Bio-Enzyme dosage on plasticity characteristics and unconfined compressive strength of soils were evaluated. It was found that with increase in Bio-enzyme dosage, the plasticity index of the soils decreases up to certain limit and then the reduction was not substantial. Studies further revealed that the increase in Unconfined Compressive strength is dependent on fines content.

Keywords: Soil, Bio-Enzyme, compaction, Ucs, Tri-axial, Lime.

INTRODUCTION

The growing metropolitan cities needs more and number of good lands for both construction activities and road development. This is the major limitation for the construction industry since most of the good lands have already been built upon.

Most of the Central part of India is covered with expansive black cotton soil appears in patches throughout the nation. Black cotton soil poses serious construction problems both to structures and highways good for construction activities. Expansive soils show swell-shrink behaviour with the variation in moisture content.

Soil stabilization is a very useful technique for major civil engineering works. To utilize the full advantage of the technique, quality control must be adequate. Soil stabilization is the alteration of one or more soil properties by mechanical or chemical means, to create an improved soil material possessing the desired engineering properties. Soils may be stabilized to prevent erosion and dust generation. Regardless of the purpose for stabilization, the desired result is the creation of a soil material or soil system that will remain in place under the desired conditions for the design life of the project. Engineers are responsible for the selecting or specifying the correct stabilizing method, technique, and quantity of material required.

Extensive research has been carried out to evaluate the effects of stabilizers such as cement, lime, chemical admixtures on improving the strength and reduce the settlement and swell-shrink nature of soils. Not much research has been carried out on utilizing bio-enzymes for stabilizing soils.

Microbial geo-technology is an emerging branch of geotechnical engineering that deals with the application of microbiological methods to improve the mechanical properties of soil to make it more fitting or appropriate for construction and environmental purposes. In this regard two noteworthy applications, bio-clogging and bio-cementation have been explored. Bio-clogging is the production of pore-filling materials through microbial means so that the porosity and hydraulic conductivity of soil can be reduced whereas bio-cementation is the generation of particle binding materials through microbial processes in situ so that the shear strength of soil can be increased [Ivanov & Chu 2008].

MATERIALS USED AND TESTS CONDUCTED

The materials used for the tests include Expansive soil, fly ash, lime and Bio-Enzyme

Table 1 Properties of Expansive soil

S.NO	PROPERTY	VALUE
1	**Grain Size Distribution**	
	Sand (%)	7
	Slit (%)	14
	Clay (%)	79
	Gravel (%)	0
2	**Atterberg Limits**	
	Liquid Limit (%)	84
	Plastic Limit (%)	39.87
	Plasticity Index (%)	44.13
3	**Compaction Properties**	
	Optimum Moisture Content,O.M.C. (%)	31
	Maximum Dry Density, M.D.D. (g/cc)	1.52
4	**Shear Strength Parameters**	
	Cohesion © (kg/cm2)	0.6
	Angle of internal friction (°)	1°
5	Specific gravity (G)	2.6
6	IS Classification	CH
7	C.B.R. (%)	2.02
8	Free Swell (%)	90

Expansive soil was obtained from Kurrada village, near ravula palem, East Godavari dist.The soil was obtained from the field was tested in the laboratory for the basic index and engineering properties.

Bio-Enzyme Dosage

The enzyme dosage varies from 200 ml/3m3 to 200 ml/1m3 of the soil, and it depends upon soil properties. In this experimental investigation enzyme dosage of 200 ml for 1m3 of soil is considered to study the variation in geotechnical properties of the selected soil. The amount of enzyme required per kg of the soil is calculated below.

Dosage:200 ml of enzyme for 1 to 3 m3 of soil.

Weight=Bulk density x volume

Bulk density of BC soil=1.77g/cc

Volume of soil for 200ml dosage=1m3=1x10^6 cc

Therefore weight of soil required for 200ml of dosage=1.77 x 1.0 x 1000=1770 kg

For 1 kg of soil, dosage required=0.113ml.For 1ml of dosage ,amount of soil required=8.85kg.

METHODOLOGY

The experimentation program of the present work was conducted in to steps.

Step 1:

- The first step finding the properties of the Virgin Soil.
- These properties include Differential Free Swell Index (DFSI), Atterberg Limits, Specific Gravity, Compaction and Tri-axial characteristics are find out.

Step 2:

In second step soil treatment is divided into **three phases**

Phase 1

In phase one the soil treated with different proportions of fly ash (5%,10%,15%,20%,25%) conducted tests:

Phase 2

In phase two the soil treated with different proportions of fly ash+Bio-enzyme (1ml) (5%,10%,15%,20% and 25%) conducted tests:

Phase 3

In phase three soil treated with combination of fly ash and Bio-enzyme (2ml) and (3ml) (5%,10%,15%,20% and 25%) conducted tests

RESULTS AND DISCUSSIONS

This section summarizes the experimental results of the compaction tests, unconfined compressive strength tests and CBR tests were conducted for the soils treated with fly ash, lime and optimized dosage of Bio-Enzyme.

RESULTS OF THE LABORATORY TESTING

Compaction Curve for Untreated Expansive Clay

The dry density vs Optimum Moisture Content of the untreated expansive clay is given in Fig 1, it can be observed that the maximum dry density as 1.52 g/cc and Optimum Moisture content is 31%.

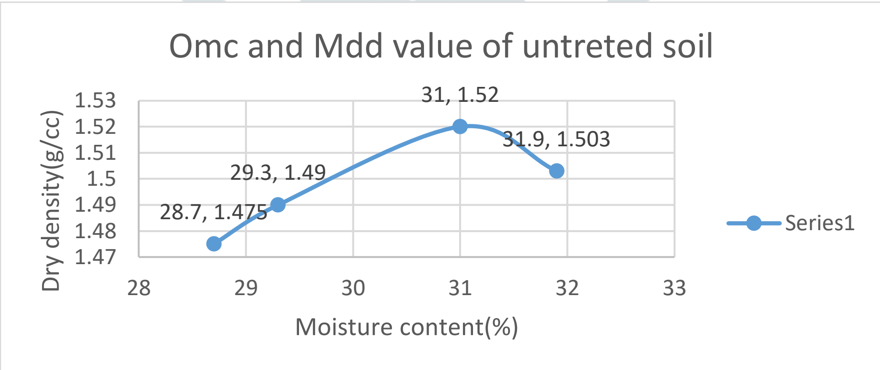

Fig 1 Optimum Moisture Content for Expansive soil

Compaction Curves for Expansive Clay Treated with various % of Fly ash

The maximum dry density and optimum moisture content for different stabilized mixtures presented in the table 1 and the variation of OMC and MDD values of Expansive clay treated with different % of fly ash are presented in the fig 2.

Type	OMC(%)	MDD(g/cc)
Soil+5% fly ash	33.9	1.362
Soil+10% fly ash	33.5	1.42
Soil+15% fly ash	32.03	1.46
Soil+20% fly ash	31.5	1.56
Soil+25% fly ash	34.15	1.35

Table: 1

OMC&MDD Values of Expansive clay Treated with various % Fly ash

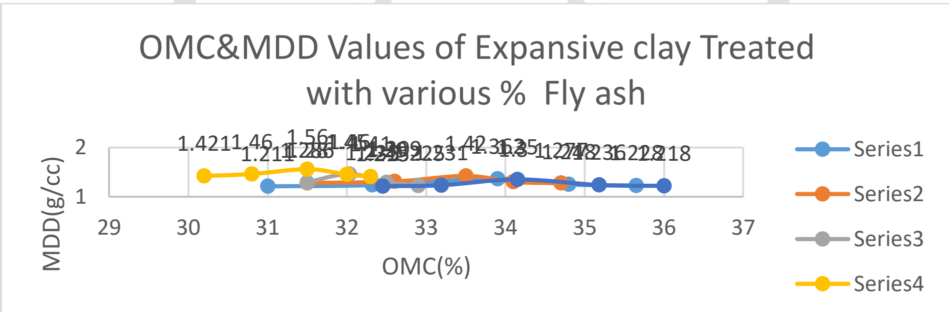

Fig 2 OMC and MDD graphs for expansive clay treated with various % of flyash

CBR Test Results of Untreated Expansive Clay and Expansive Clay Treated with Fly ash

The load vs penetration for the Untreated Expansive Clay is given in fig 4.3 it can be observed that the soaked CBR value is 2.02% and Unsoaked CBR value is 4.18%.

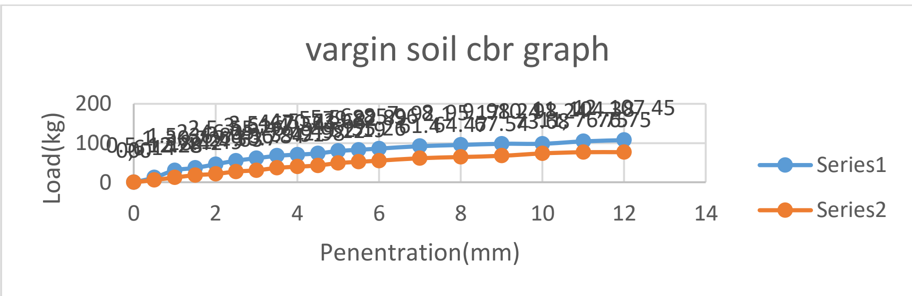

Fig 3 CBR graphs for Expansive clay

CBR Test Results for Expansive Clay Treated with Various % of Fly ash

The CBR values for different stabilized mixtures in the table 2 and the variation of CBR values for expansive clay treated with various % of fly ash are presented in the fig 4.

Type	CBR(%)(Soaked)
Soil+5% fly ash	2.96
Soil+10% fly ash	3.13
Soil+15% fly ash	3.05
Soil+20% fly ash	3.36
Soil+25% fly ash	3.13

Table 2

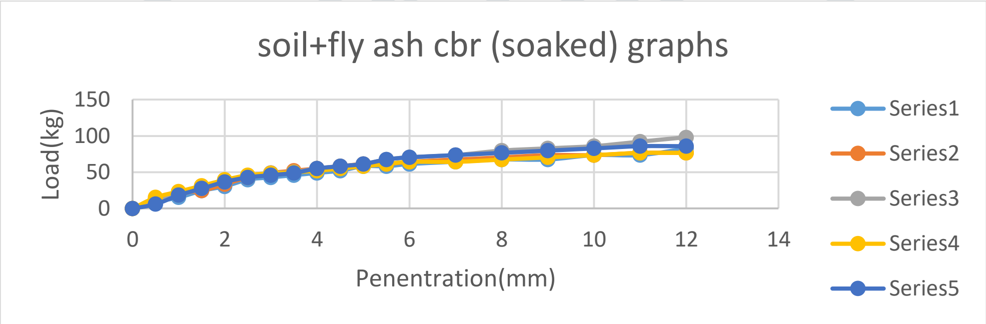

Fig 4 CBR values of Expansive clay treated with various % of fly ash

OMC&MDD Values of Expansive Clay, Fly ash treated with various % of Bio-Enzyme

The maximum dry density and optimum moisture content for different stabilixzed mixtures presented the table 3 and the variation of OMC and MDD values of expansive clay, fly ash are treated with various % of Bio-Enzyme are presented in the fig 5

Type	OMC(%)	MDD(g/cc)
Soil+20% fly ash+1ml BA	35.1	1.79
Soil+20% fly ash+2ml BA	34.42	1.91
Soil+20% fly ash+3ml BA	34.33	1.85

Table: 3

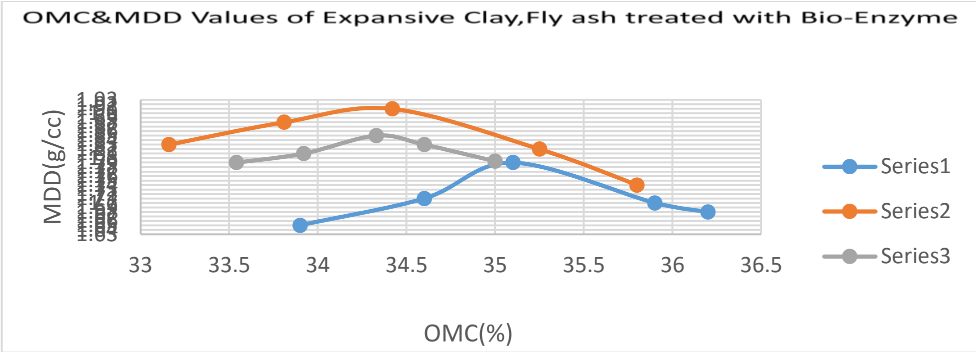

Fig.5 OMC and MDD graphs for expansive clay and flyash treated with various % of Bio-Enzyme

CBR Values of Expansive Clay, Fly ash treated with Bio-Enzyme

The CBR values for different stabilized mixtures presented in the table 4 and the variation of CBR values of expansive clay, flyash treated with different % of Bio-Enzyme are presented in the fig 6.

Type	CBR(%)
Soil+5% FA+1ml BE	9.43
Soil+5% FA+2ml BE	12.52
Soil+5% FA+3ml BE	10.30

Table: 4

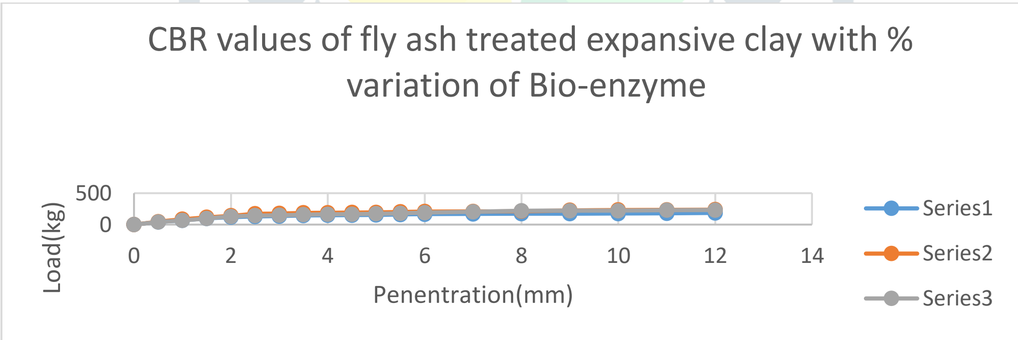

Fig. 6 CBR graphs for expansive clay and fly ash treated with various % of Bio-Enzyme

OMC&MDD Values of Expansive Clay, Fly ash treated with various % Lime

The maximum dry density and optimum moisture content for different stabilized mixtures presented the table 5 and the variation of OMC and MDD values of expansive clay, fly ash and Bio-Enzyme are treated with various % of Lime are presented in the fig 7

Type	OMC(%)	MDD(g/cc)
Soil+20% fly ash+2ml BA+1%lime	36.9	1.93
Soil+20% fly ash+2ml BA+2%lime	35.4	1.957
Soil+20% fly ash+2ml BA+3%lime	34.3	1.981
Soil+20% fly ash+2ml BA+4%lime	33.9	1.954

Table: 5

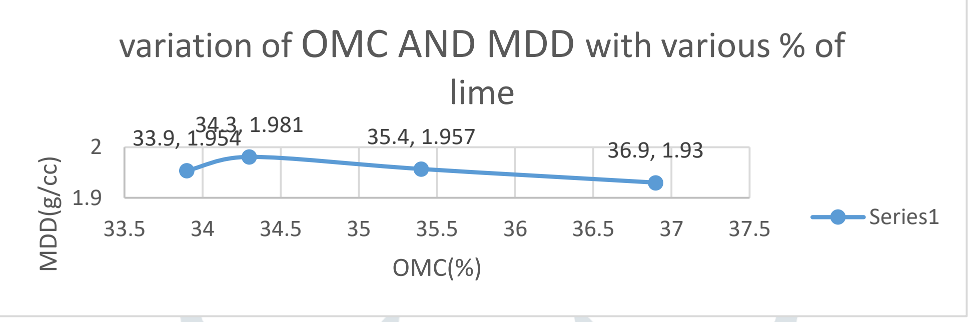

Fig: 7 OMC and MDD graphs for Expansive clay, fly ash and Bio-Enzyme treated with various % of Lime

CBR Values of Expansive Clay, Fly ash treated with various % Lime

The CBR values for different stabilized mixtures presented in the table 6 and the variation of CBR values of expansive clay, flyash, and Bio-Enzyme are treated with different % of Lime are presented in the fig 8.

Type	CBR(%)
Soil+20% fly ash+2ml BA+1%lime	13.3
Soil+20% fly ash+2ml BA+2%lime	14.7
Soil+20% fly ash+2ml BA+3%lime	15.6
Soil+20% fly ash+2ml BA+4%lime	14.2

Table: 6

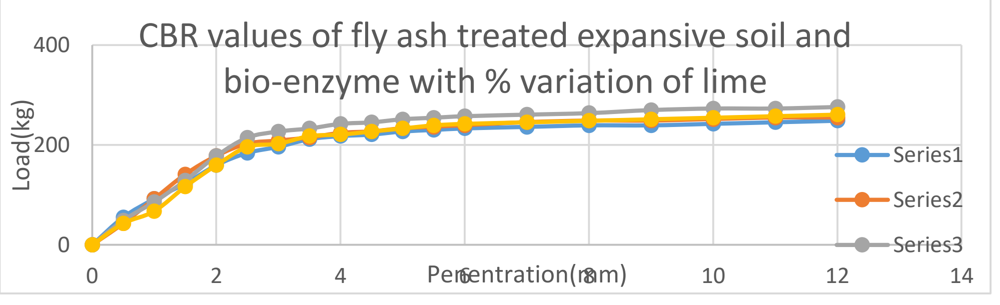

Fig. 8 CBR graphs for Expansive clay, fly ash and Bio-Enzyme treated with various % of Lime

Ucc for Untreated soil

The stress vs strain of the untreated expansive clay is given in the fig 9, it can be observed that the unconfined compression value is 1.27 kg/cm^2.

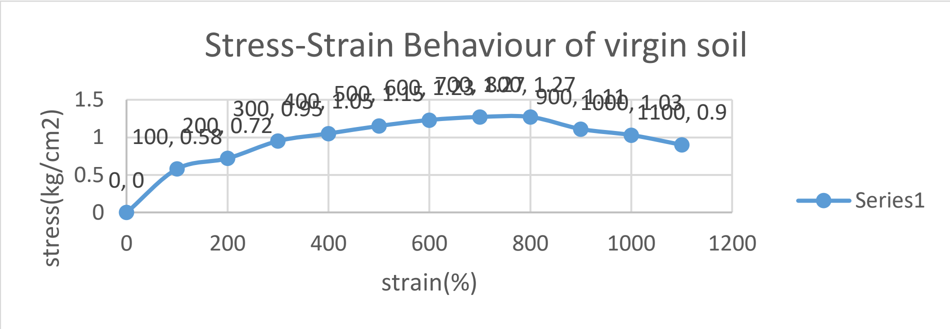

Fig. 4.9

UCC Values of Expansive clay Treated with various % Fly ash

The UCC values for different stabilized mixtures presented in the table 7 and the variation of UCC values of expansive clay treated with different % of fly ash are presented in the fig 10.

TYPE	UCS(Kg/cm2)
Soil+5%FA	1.29
Soil+10%FA	1.33
Soil+15%FA	1.389
Soil+20%FA	1.428
Soil+25%FA	1.38

Table:7

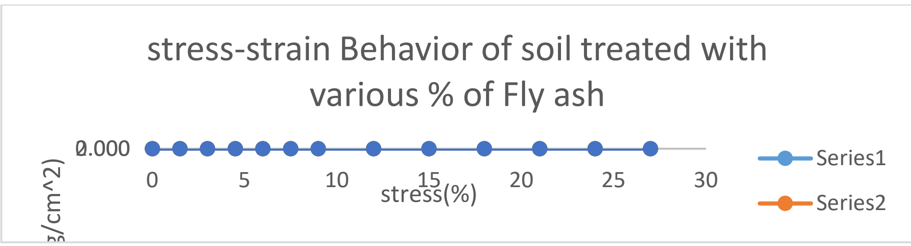

Fig. 10 UCC values of expansive clay treated with various %of fly ash

UCC Values of Expansive Clay, Fly ash treated with Bio-Enzyme

The UCC values for different stabilized mixtures presented in the table 8 and the variation of UCC values of expansive clay, flyash are treated with different % of Bio-Enzyme are presented in the fig 11.

TYPE	UCS(Kg/cm2)
Soil+20%FA+1ml BE	2.24
Soil+20%FA+2ml BE	2.57
Soil+20%FA+3ml BE	2.97

Table: 8

Ucc Values of Expansive Clay, Fly ash treated with Bio-Enzyme

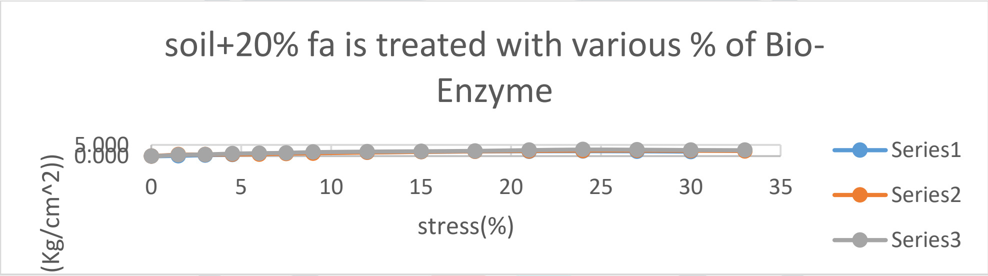

Fig. 11 UCC graphs for expansive clay and fly ash treated with various % of Bio-Enzyme

UCC Values of Expansive Clay, Fly ash, and Bio-Enzyme treated with various % Lime

The UCC values for different stabilized mixtures presented in the table 9 and the variation of UCC values of expansive clay, flyash, and Bio-Enzyme are treated with different % of Lime are presented in the fig 12.

TYPE	UCS(Kg/cm2)
Soil+20%fa+2ml BA+1% lime	3.15
Soil+20%fa+2ml BA+2%lime	3.23
Soil+20%fa+2ml BA+3%lime	3.42
Soil+20%fa+2ml BA+4%lime	3.47

Table:9

Ucc Values of Expansive Clay, Fly ash treated with various % Lime

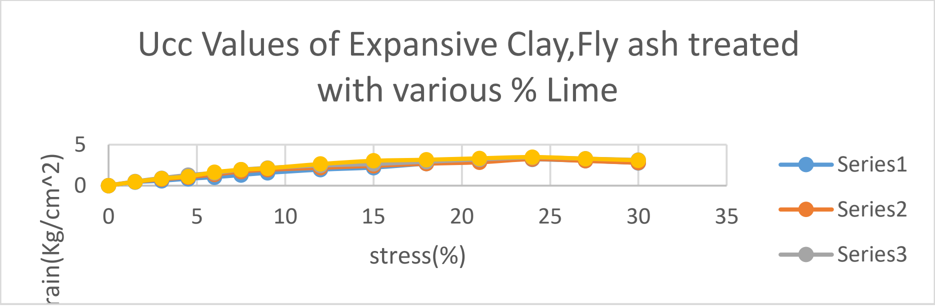

Fig.12 UCC graphs for expansive clay and fly ash and Bio-Enzyme treated with various % of Lime.

CONCLUSIONS

The stability of Bio-Enzyme for the modification of Geotechnical properties of expansive and non-expansive soils is concluded by studying the effect of Bio-Enzyme on the index and engineering properties of black cotton soil.

1. When Bio-Enzyme is added to soil up to 2 ml, there is a considerable increase in MDD values. Whereas a further increase of Bio-Enzyme liquid leads to decrease in MDD values.
2. When fly ash is added to soil up to 20%, there is a considerable increase in MDD values. Whereas a further increase of fly ash leads to increase in MDD values.
3. When combination of(fly ash (20%)+Bio-Enzyme (2ml)+lime (3%)),there is a considerable increase in MDD values. Whereas a further increase of combinations the MDD values decreases.
4. When soil is treated with fly ash there is increase in CBR value up to 20%when a further increase of fly ash there is decrease in CBR value both in soaked and unsoaked condition.
5. When combination of(fly ash (20%)+Bio-Enzyme (2ml)+lime (3%)),there is a considerable increase in CBR values. Whereas a further increase of combinations the CBR values decreases.
6. When the increase of CBR values is 7.7 times of the virgin soil.
7. The unconfined compressive strength tests were carried out for 3 different combinations like soil and fly ash, soil and fly ash and bio-enzyme, soil and fly ash and bio-enzyme and lime. From the stress strain behavior is increases from the combination of soil, fly ash, bio-enzyme and lime

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