STUDY ON CHARACTERISTICS OF BLACK COTTON SOIL STABILIZED WITH ENVIROTAC-II AND LIME

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Abstract: Exapansive soils, such as black cotton soils, are basically susceptible to detrimental volumetric changes with change in their moisture content In developing countries like India, the biggest hurdle in the path of providing a complete network of road system is the limited funds available to construct roads by conventional methods. Utilization of locally available materials can considerably decrease the construction cost. For instance, utilizing local soils for the construction of lower layers of the pavement such as sub-base course can bring down the construction cost considerably. But, soil may show different characteristics at different stretches or even at the same stretch. In many places in India, the soils are not stable enough to support the wheel loads. Hence, soil stabilization comes into picture. The properties of the soil can be improved by soil stabilization techniques to meet the designed standards. In this regard, present work concentrates on investigating the effectiveness of Envirotac II, a vinyl acetate acrylic copolymer, in stabilizing problematic soil which is taken from the construction site at Halagur, Mandya. Soil sample obtained from the site is stabilized with Envirotac-II in various proportions (i.e. 0.5%, 0.75%, 1.5% and 2.25%) and 4% Lime is constant throughout the experiments. They are subjected to extensive laboratory investigations in accordance with standard specifications. From the laboratory studies, it is found that comparatively there is a considerable improvement in the properties of the soil stabilized with Envirotac-II than the soil without stabilization.

Keywords: expansive soil, vinyl acetate acrylic co-polymer, lime

I. INTRODUCTION

In India, approximately 52 million hectares area of land is shielded by expansive BC soil. In wet condition, the BC soil damages its strength fully and it is stiff in dry state. This expansive BC soil is problematic soil that gives numerous experiments for civil engineers. In India, expansive BC soil is superior known as 'Regurs' and it is establishing in broad districts of Deccan trap. They contain in different thickness. BC soil is lie beneath by sticky material property and known as "Kali Mitti". As far as geotechnical engineering properties, BC soil is one which when connected with as designing structure and in the occurrence of moistness content will describe an inclination to swell to shrink causing structure to experience moments which are random to immediate act of loading to the structure. In India, approximately $1/6^{th}$ part of soil exists enclosed by black cotton. The region covering of black cotton soil is generally the Deccan Trap level, Between 73°80˝ East longitude and 15° to 24° north, scope. In this way, most of black cotton soil is contain around Mumbai, Gwalior, Madras, Khandwa, Indore, Nagpur and even certain several of the banks of river black cotton soil is found. This implies that these soils are dictating in Deccan deception level districts i.e., in conditions of Andhra Pradesh, Madhya Pradesh, Gujarat, Uttar Pradesh and Karnataka.

II. EXPERIMENTAL STUDY

2.1 SOIL

Soil sample for the present study was collected alongside NH:209 near Halagur town, Malavalli taluk, Mandya district. The current soil is subjected to various laboratory study in the research facility to record physical properties of soil.

Table 1 physical properties collected BC soil

SL.No.	Properties	Values
1	Sieve analysis	Cu=9.59 Cc=1.37
2	Specific gravity	2.57
3	Atterberg's limits	
	Liquid limit (%)	61
	Plastic limit (%)	40
	Plasticity index	21
4	Compaction characteristics	
	Maximum dry density(g/cc)	1.44
	Optimum moisture content (%)	28
5	CBR test results	
	Unsoaked CBR value (%)	2.63
	Soaked CBR value (%)	2.23
6	Confined compression strength(N/cm^2)_	1.59
7	Soil classification	
	BIS system	CH
	HRB system	A-7-5

fig 1 Soil sample

2.2 ENVIROTAC II CHEMICAL

Envirotac II is a water solvent vinyl acetic acid derivation acrylic co-polymer and it is indicating Elite, naturally protected, temperate acrylic co-polymer. Nature of Envirotac II is high adhesive capacity. Envirotac II is connected to every atom of soil molecule tends to frames water evidence course, UV safe, strong security which security the soil molecule by when connected to soil, it infiltrates and coats the surface and when dried. It made highly durable surface which with stands dense traffic loads by adding optimum dosage of Envirotac II.The DOW chemical company assessed the protection of vinyl acetate-acrylic co-polymer product. Safety aspects of regarding chemicals provide the data sheets by official website EP&A.Envirotac II, when applied, will enter in to the soil, attachment between soil particle and chemicals and binding them place. Envirotac II is contains fixed of polymers and manufactured with the environmental in mind. These polymers are safe to treat soil with and determination not harms humans or wild life. Envirotac II is applied on soil increase load bearing ability in areas of streets, parking garages, trails, helipads and other overwhelming movement ranges at lowercost.Envirotac II is a result of environmental products. Application of chemicals which is a US based organization. The United States Military has been utilizing these for a long time. It is the most utilized dust control compound by United States Military in the Middle East. In Arizona, it was effectively connected over the demonstrating justification for soil adjustment with the goals that helicopters could arrive tidy free over the sandy territories.

2.3 METHODOLOGY

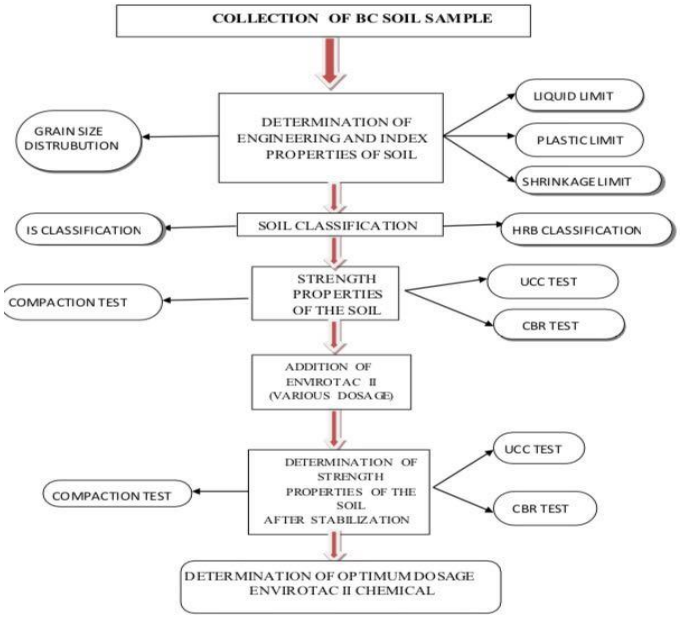


Fig 2 Envirotac II

2.4 EXPERIMENTAL PROCEDURE AND DOSAGE OF ENVIROTAC II

COMPACTION TEST-Initially in compaction test is conducted and carried out by taking 0.5% of Envirotac II with weight of the soil and it is diluted in the ratio of 1:4 and 4% of lime as constant throughout the project. All are mixed thoroughly in dry state. According to curing standards of soil is to evaluate the MDD and OMC of soil sample. Same procedure is conducted to varying dosage of Envirotac II say, 0.75%, 1.5% and 2.25% etc. and repeat the procedure is conducted and improvements in MDD and OMC is tabulated.

CBR TEST -Take 0.5% of EnvirotacII by weight of soil and diluted it with water at a ratio of 1:4i.e., 0.5% of 5000gm is 25ml. it is diluted by 100ml of water forms 125ml of Envirotac II solution in to a soil. Add this solution in to soil and mix it thoroughly along with 4% lime. The 4% lime is constant throughout the project with varying dosage. From the OMC deducting this much quantity gives the amount of water to be added. The OMC can be calculated by using compaction test. According to CBR procedure adding calculated amount of water CBR test specimen is prepared using the standard procedure. Then the compacted soil kept for curing for 7days, after curing the diluted solution of EnvirotacII is applied

on the surface of specimen at a rate of 0.25l/m^2 and again it is left for frying. Then the specimen is taken for CBR test. Similarly, by varying dosage of Envirotac II say, 0.75%, 1.5%, 2.25% etc. the improvements in CBR value are observed. CBR is also done for soaked condition.
Soils performance is evaluated via compaction test and CBR test at different dosages of Envirotac II. The dosage which gives the greater values of MDD and CBR value is noted and established as optimum.

III. STABILIZED SOIL PROPERTIES WITH ENVIROTAC II AND LIME

SPECIFIC GRAVITY:

Comparatively 1.5% Envirotac II solution added to the soil gives maximum specific gravity value compare to other dosages and hence it is called optimum dosages.The percentage increases in specific gravity with different dosages are shown in below graph

Dosage of Envirotac II in %	Specific gravity
Untreated	2.57
0.5	2.6
0.75	2.63
1.5	2.67
2.25	2.65

Table2 specific gravity values of various dosage

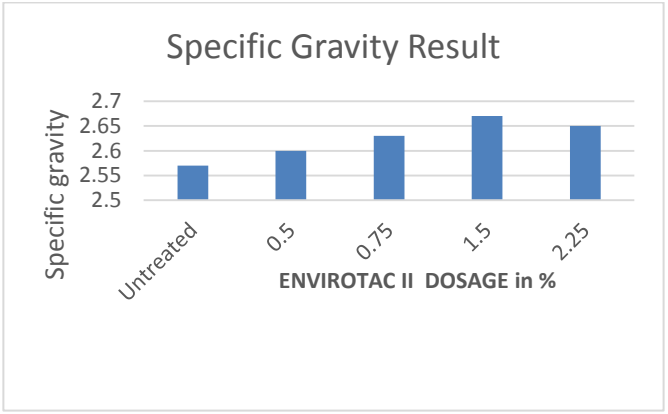


fig 3 graphical representation of SG values

ATTERBERG LIMITS OR CONSITENCY LIMITS:

After the addition of Envirotac II in different dosages and shows the slight decrease in the liquid limit, plastic and plastic index values.

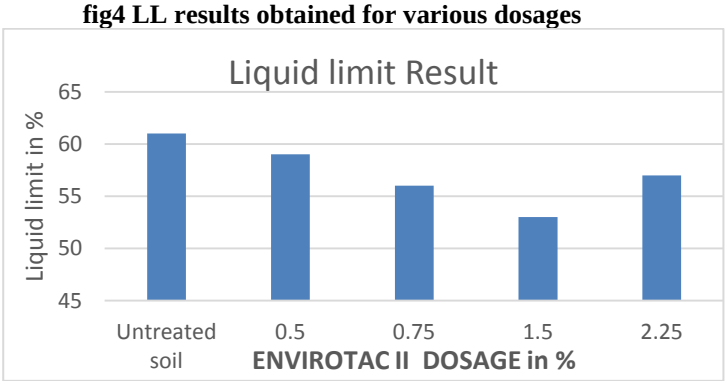
Liquid Limit: The observation and description of reference to above results are:

The liquid limit of the Envirotac II treated with soil sample for various dosages is decreased compared to the unsterilized soil sample.From the above results shows the 1.5%Envirotac II dosage the liquid limit is more decreased compare to other and hence this one can be decided as the optimum dosage The results obtained by various dosage of Envirotac II is represented graphically below:

Table3 Test results of Liquid limit

Dosage of Envirotac II in %	Liquid limit in %
Untreated soil	61
0.5	59
0.75	56
1.5	53
2.25	57

fig4 LL results obtained for various dosages

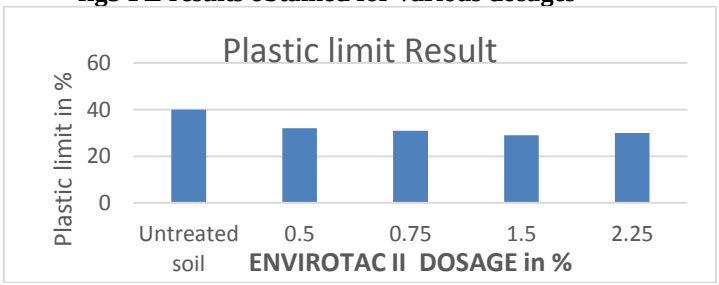


PLASTIC LIMIT: The plastic limit of the unstabilized soil 40% and when the soil treated with stabilizer the plastic limit of the soil is slightly decreased. The graphical portrayal of plastic limit test comes about is demonstrated as follows

Table4 test results of plastic limit

Dosage of Envirotac II in %	**Plastic limit in %**
Untreated soil	40
0.5	32
0.75	31
1.5	29
2.25	30

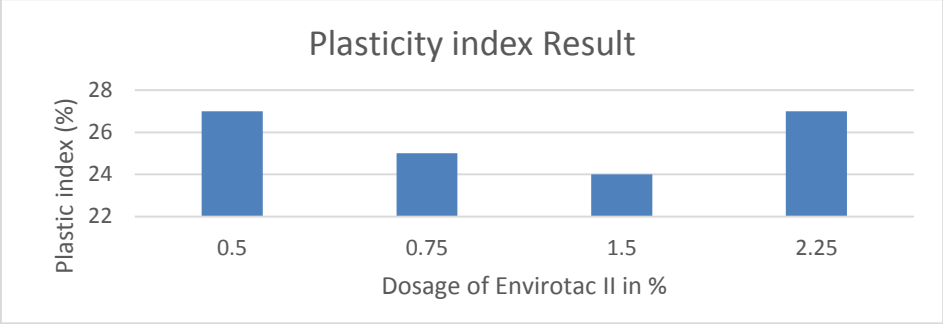
fig5 PL results obtained for various dosages



PLASTICITY INDEX:

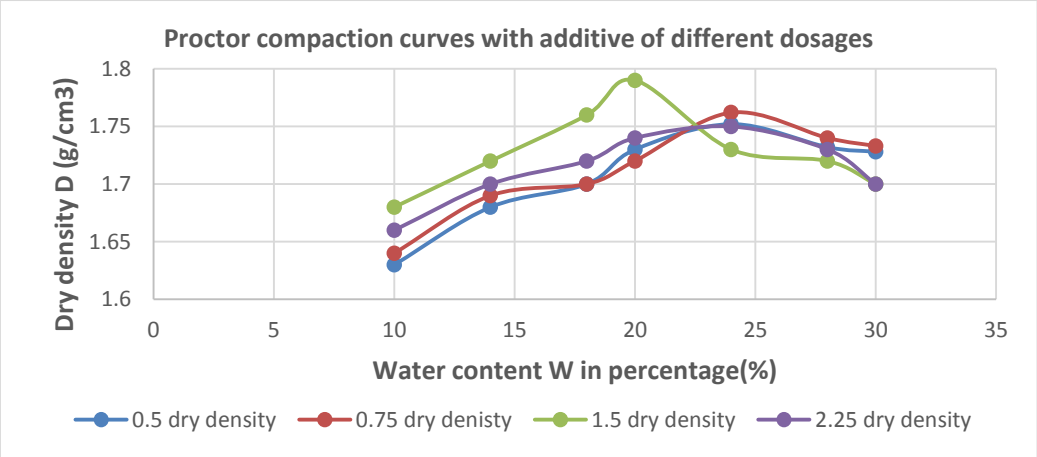
Plastic index is the variance among liquid limit and plastic limit of the soil sample.

Fig6 plasticity index result with EnvirotacII



COMPACTION TEST RESULTS:

Fig 7 compaction curve with additive of different dosages



Proctor compaction curve with additive of different dosage

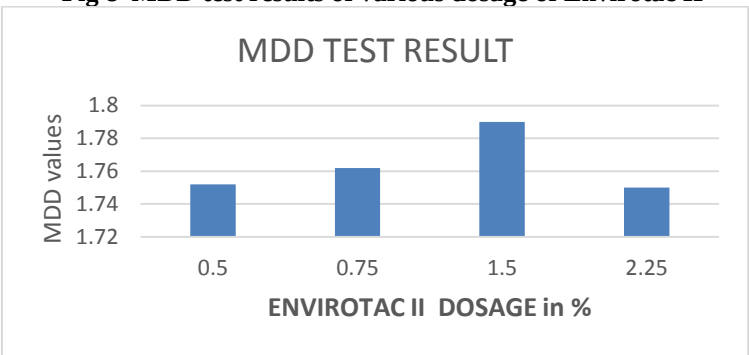
MAXIMUM DRY DENSITY (MDD) TEST RESULTS:

When the Envirotac II is used trendy stabilization of BC soil sample the following observation are recorded and shows the connection between dry density and humidity content for various dosage of stabilizer.

Table5 MDD test results

DOSAGE IN %	MDD IN g/cc
0.5	1.752
0.75	1.762
1	1.77
1.5	1.79
2.25	1.75

Fig 8 MDD test results of various dosage of Envirotac II



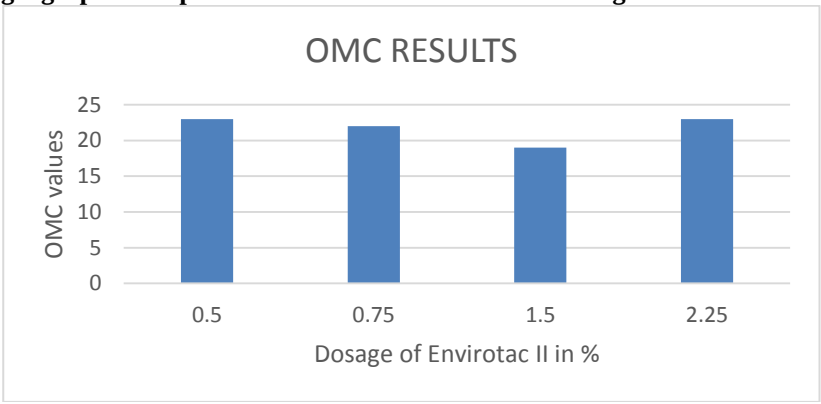
OPTIMUM MOISTURE CONTENT EXPERIMENTAL RESULTS:

The table denotes the OMC obtained at various dosages of Envirotac II solution.

Table6 OMC test results

DOSAGE IN %	OMC IN %
0.5	23
0.75	22
1.5	19
2.25	23

Fig 9 graphical representation of OMC for various dosage of Envirotac II



STABILIZED CBR TEST RESULTS:

Table7 Stabilized CBR test results

ENVIROTAC II DOSAGE IN%	SOAKED CBR VALUE IN%
0.5	17
0.75	22
1.5	26.2
2.25	24.5

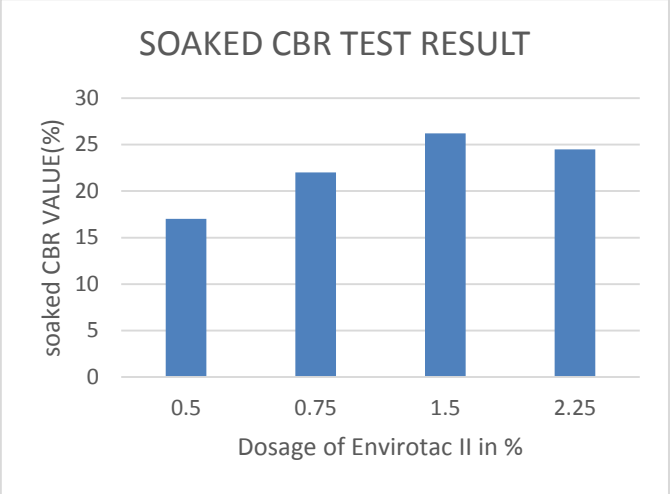
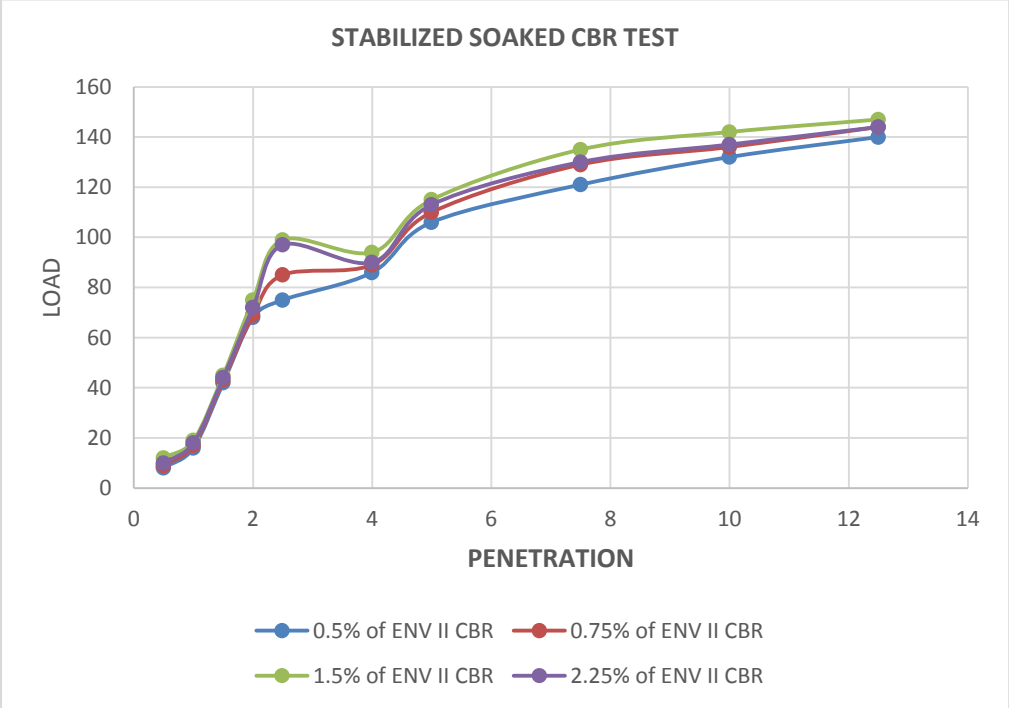


Fig 10 Graphical representation of CBR values is shown



Stabilized soaked CBR test

STABILIZED UCS RESULTS:

Table8 stabilized UCS test results

Envirotac II dosage in %	Unconfined compression strength N/cm2
0.5	8.3
0.75	11.52
1.5	17.16
2.25	15.14

fig 11 graphical representation of stabilized UCS results

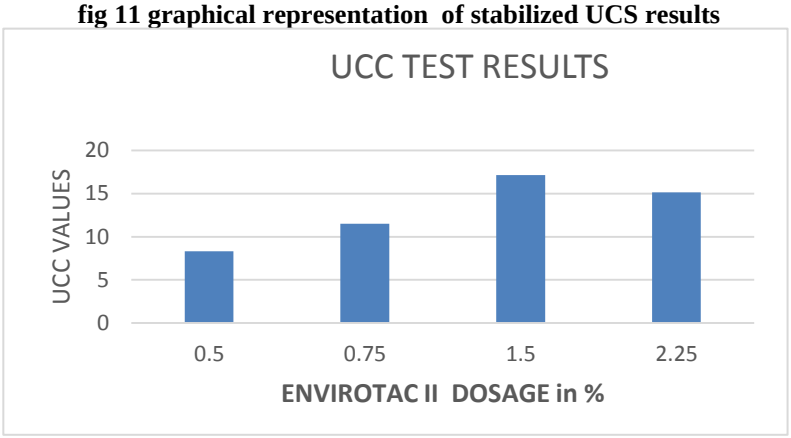
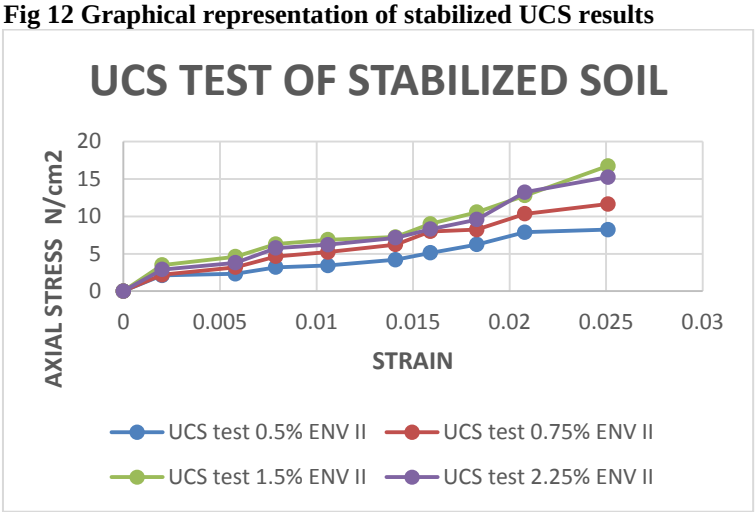


Fig 12 Graphical representation of stabilized UCS results



RELATIONSHIP BETWEEN ENVIROTAC II AND MDD, UCS RESULTS, CBR TEST

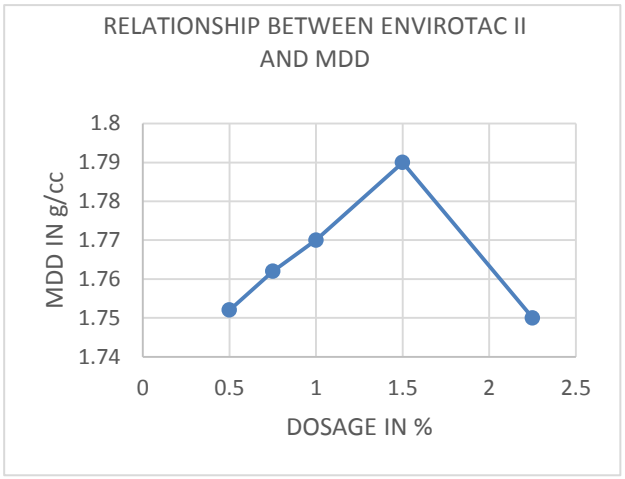


Fig13 Relationship between Envirotac II and MDD:

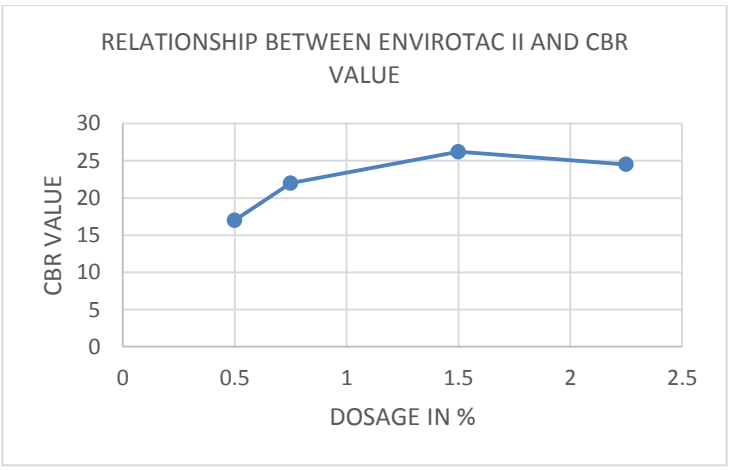


fig14 Relationship between Envirotac II and soaked CBR

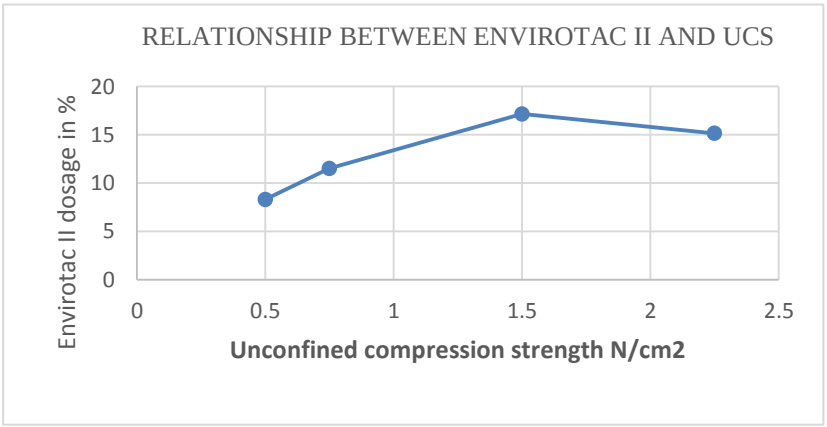


Fig 15 Relationship between Envirotac II and UCS

IV. CONCLUSION

From the laboratory investigations of stabilized black cotton soil with Envirotac II stabilizer, the succeeding conclusions are drawn:

- With Envirotac II dosage **of 0.5%, 0.75%, 1.5%** and **2.25%** the MDD of the soil was found to be 1.752g/cc, 1.763g/cc, 1.79g/cc and 1.75g/ccrespectively
- With Envirotac II dosage **of 0.5%, 0.75%, 1.5%** and **2.25%** the soaked CBR value is found to be **17%, 22.2%, 26.5%** and **24.8%**respectively.
- With Envirotac II dosage **of 0.5%, 0.75%, 1.5%** and **2.25%** the UCS results was found to be **8.3 N/cm^2, 11.52**

N/cm^2, 17.16 N/cm^2 and 15.14 N/cm^2 respectively.

- From the above observations are concluded that **1.5% ENVIROTAC II** is the optimum dosage for Black Cotton soil sample obtained from Halagursite.
- It can be observed from the test results that addition of Envirotac II with the soil considered for the study resulted in decrease of Liquid limit and plastic limit. It can be concluded that there is an improvement in the index properties of soil by the usage of EnvirotacII

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