International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 5 Issue 6, September-October 2021 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

An Experimental Study on Soil Stabilization by Using Bio-Enzymes

Anushka Shrivastava[1], Dr. Anil Kumar Saxena[2]

[1]Research Scholar, [2]Professor,
[1,2]Lakshmi Narain College of Technology, Bhopal, Madhya Pradesh, India

ABSTRACT

Normal The conventional methods are time consuming and are not efficiently feasible. Hence there is a need to find the other possible ways to assure the performance as well as economical criteria. These enzymes have been confirmed to be very effective and economical. Another benefit of the bioenzyme is that these are environment friendly. The efficiency of bio enzyme depends upon the quantity of dosage, type of soil and curing period. In our country vast areas consist of black soils. As the conservative soil stabilizers like gravel, sand and others are depleting and becoming dear day by day at a very rapid pace, it becomes essential to look towards for alternative eco-friendly stabilizers as their alternate. Recently a lot of Bio-enzymes have emerged as cost effective stabilizers for soil stabilization. Some such type of bio-enzyme, like Terazyme, bagasse ash, lime etc. has been used in the present work. Recently many Bio-enzymes have emerged as value powerful stabilizers for soil stabilization. One such bio-enzyme, Terrazyme, has been used within side the gift paintings to take a look at its impact at the Unconfined Compressive electricity of the Black Cotton soil. It has been located that Terrazyme dealt with Black Cotton soil suggests vast boom in Unconfined Compressive electricity with longer curing period.

***KEYWORDS:** Black Cotton Soil, Bagasse ash, Stabilization, Lime, Liquid Limit, Plastic Limit, CBR test, bioenzyme*

How to cite this paper: Anushka Shrivastava | Dr. Anil Kumar Saxena "An Experimental Study on Soil Stabilization by Using Bio-Enzymes" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-5 | Issue-6, October 2021, pp.1644-1650, URL: www.ijtsrd.com/papers/ijtsrd47686.pdf

IJTSRD47686

I. INTRODUCTION

Black cotton is one of the expansive soil available in India. Black cotton soil is an expansive soil that generally available in the tropical zones. Their appearance varies from black colour to brown color. In our country black cotton soil occupies nearly 20% of the available land. Expansive soil principal component typically determined in relevant component and a few locations in south India. Expansive soils recognized through black cotton soil are to be had within side the Deccan plateau fields (Deccan Trap) together with Madhya Pradesh, Maharashtra, Gujarat, Andhra Pradesh and in a few components of Odisha, within side the Indian sub-continent. Black cotton soil to be had within side the valley of river Tapti, Narmada, Godavari and Krishna. The west side of Deccan plateau and in upper portion of Krishna and Godavari basin. In this area the black cotton soil depth is very narrow. These soils formed by the residual action of basalt or trap rocks. The other reason behind formation of these soils is weathering of igneous rocks, after volcanic eruption by the cooling action of lava. These soil shows high plasticity nature. The major clay mineral is montmorillonite. Because of montmorillonite group mineral those clays showcase greater swelling and shrinkage characteristic. The predominant trouble with this form of minerals is instability of earth material. Expansive soils are difficult once they lose water content, and the some other day in the event that they seize water they emerge as smooth in nature. In Maharashtra area the expansive soils are diagnosed with the aid of using name “Black 1Cotton” soil. These soils own vulnerable homes because of presence of clay minerals recognised as “Montmorillonite”. Typical behaviour of soil outcomes into failure of shape in shape of settlements cracks etc.

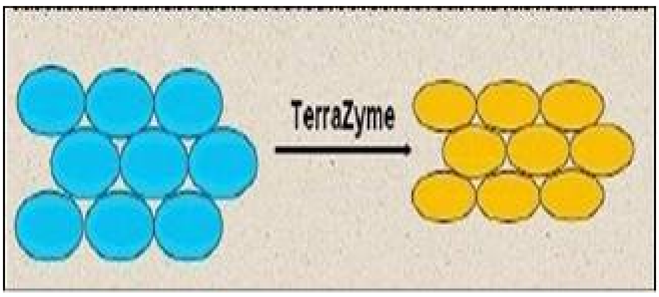
II. OBJECTIVES OF RESEARCH WORK:

To study the physical and mechanical performance of industrial waste polymer fiber used in the concrete mixtures.

1. To prepare the various proportions of polymer modified concrete using industrial waste fiber.
2. To determine the optimum use of industrial waste fiber in the cement concrete mix, which produces the best concrete of having better properties like density test, compressive strength and split tensile strength.
3. To inspect the opportunity of using industrial waste fibre in cement concrete mixture.
4. To determine the compressive strength, split tensile strength of the polymer modified concrete which is made of industrial waste fibre.

III. LITRATURE RIVEW

The **Rajni S. Chandran, Padmakumar G.P (2009)** lime is an unparalleled aid in ***the*** modification and stabilization of soil beneath road and similar construction projects. Use of lime can substantially increase the stability, impermeability, and load bearing capacity of the sub grade. Black cotton soil can be stabilized by the addition of small percentages, by weight of lime thereby enhancing main of the engineering properties of the soil and thus produces an improved construction material. The strength developed is obviously influenced by the quantity of cementations gel produced. consequently on the amount of lime consumed and curing period. Dry lime used for stabilization cause dust allergy and is corrosive to human skin and so lime solution was used in the study. The soil used in the study is clay from Thonnakal in Trivandrum district, in which kaolinite mineral is predominant. The lime solution with different concentrations were added to the soil samples for stabilization and cured with water for 7, 14, 21, 28 and 35 days. Results showed that optimum concentration of lime solution that gives the highest soil strength is the optimum concentration of lime solution for soil stabilization. From the test results, it was also found that the imconfmed compressive strength increased up to a curing period of 28 days and thereafter there are no appreciable effects.



Shukla et al. (2003) used Bio-Enzymes to stabilize 5 unique varieties of soil starting from low clay content material to very excessive clay content material, engineering houses and energy traits have been decided and it turned into located that there may be little to excessive development in bodily houses. Little development might be because of soil constituent, which has low reactivity with Bio-Enzymes. There turned into development in CBR and unconfined compression energy of soils like silty soil to sandy soil. An growth of sixty five to 252% in UCS fee turned into determined after four weeks of curing. Pavement layout thickness additionally reduces to twenty-five to forty percent. Moreover, in case of shortage of granular material, best stabilized floor with skinny bituminous surfacing can satisfy the pavement layout requirement. Sharma (2006) has performed laboratory research on use of bio-enzyme stabilization of 3 varieties of soils specifically clay of excessive plasticity (CH), clay of low plasticity (CL) and silt of low plasticity (ML). It turned into located that the CH soil had an growth in CBR fee with discount in saturation moisture from forty to 21□ter four weeks of stabilization. Also it turned into located that there has been 100% growth in unconfined compression energy.

Shankar et al. (2009) studied the impact of various dosages of Bio-Enzymes on Lateritic soil of Dakshina Kannada (district of India), having liquid restrict and Plasticity Index greater than 25% and 6% respectively. Tests have been performed on lateritic soil through including unique chances of sand as well. They concluded that there may be medium development in bodily houses of lateritic soil. Therefore it turned into cautioned that impact of Bio-Enzyme on soil must be tested in laboratory earlier than real discipline application. Higher dosage (200ml/2m3 of soil) produced 300% growth in CBR, 450% in unconfined compressive energy and permeability turned into decreased through 42□ter 4 weeks of curing. It turned into additionally determined that enzyme isn't powerful for brotherly love much less soil.

Venkatasubramanian & Dhinakaran (2011*)* performed exams on 3 soils with various houses and unique dosages of Bio-Enzyme. Three soils had liquid limits of 28, 30 and 46% and plasticity index of 6, five and 6%. Increase in unconfined compressive energy after four weeks of curing turned into said as 246 to 404%.

IV. METHODOLOGY:-

In clay water mixture positively charged ions (cat-ions) are present around the clay particles, creating a film of water around the clay particle that remains attached or adsorbed on the clay surface.

The adsorbed water or double layer gives clay particles their plasticity. In a few instances the clay can swell and the dimensions of double layer increases, however it may be decreased with the aid of using drying. Therefore, to virtually enhance the soil properties, it's far vital to completely lessen the thickness of double layer. Cat-ion alternate approaches can accomplish this. By using fermentation approaches precise micro-organisms can produce stabilizing enzyme in massive quantity. These soil-stabilizing enzymes catalyze the reactions among the clay and the natural cat-ions and boost up the cat-ionic alternate without turning into a part of the give up product.

TerraZyme replaces adsorbed water with natural cations, as a result neutralizing the terrible price on a clay particle. The natural cations additionally lessen the thickness of the electric double layer. This lets in TerraZyme dealt with soils to be compacted extra tightly together.

TerraZyme resists being replaced by water, thus reducing the tendency of some clay to swell. TerraZyme promotes the development of cementatious compounds using the following, general reaction:

$$H_2O + Clay \xrightarrow{Terrazyme} \text{Calcium Silicate Hydrates}$$

TEST ARE PERFORMED AS FOLLOWS

1. Determination of chemical composition of sugar cane bagasse ash
2. Soil Classification
3. X-ray analysis method of Black Cotton soil
4. Grading test
5. Moisture Content
6. Specific Gravity
7. Specific Gravity
8. Atterberg Limits
9. Liquid Limit
10. Plastic Limit
11. Plasticity Index
12. Maximum Dry Density
13. Optimum Moisture Content
14. California Bearing Ratio

V. RESULT & DISCUSSIONS

Chemical Analysis of SCBA

The chemical analysis indicated that the ash contained mainly silica, calcium, magnesium and aluminium with other minor elements Table 4.1. The combined percent composition of SiO_2, Al_2CO_3 and Fe_2O_3 of the ash is more than 70% hence exhibits pozzolanicity property.

Table 4.1: Chemical analysis of Bagasse Ash

Description	Abbreviation	Ash (%)
Silica	SiO_2	66.23
Iron	Fe_2O_3	3.09
Calcium	CaO	2.81
Magnesium	MgO	1.54
Sodium	Na_2O	0.26
Potassium	K_2O	6.44
Loss of Ignition	.	16.36
Alumina	Al_2O_3	1.90
Titanium	TiO_2	0.07
Manganese	MnO	0.60

Black cotton Soil

Results of the study on physical properties on neat sample of soil is given in Table 4.2 and indicated that the sample belonged to black cotton soil. Most of the properties required to be improved to meet engineering standard.

Table 4.2 Properties of black cotton soil

PROPERTY	QUANTITY
Colour	Grayish black
Percentage passing No. 200 sieve, %	99.4
Liquid limit, %	67
Plastic limit, %	32
Plasticity index, %	35
AASHTO soil classification	A.7.5
Free swell, %	0.7
Specific gravity	2.65

Maximum dry density, kg/m^3	1240
Optimum moisture content, %	26.4
Soaked CBR value, %	11

The chemical analysis of black cotton according to (Ramesh et al.) is shown in Table 4.2. The main components are silica (SiO_2) 52.85% and alumina (Al_2O_3) 12.24%, loss of ignition is 16.18%

Table 4.3: Chemical analysis of black cotton Black Cotton

Description	(%)
Silica	52.85
Iron	8.04
Calcium	6.01
Magnesium	0.48
Sodium	0.26
Loss of Ignition	16.18
Alumina	12.24
Titanium	0.24

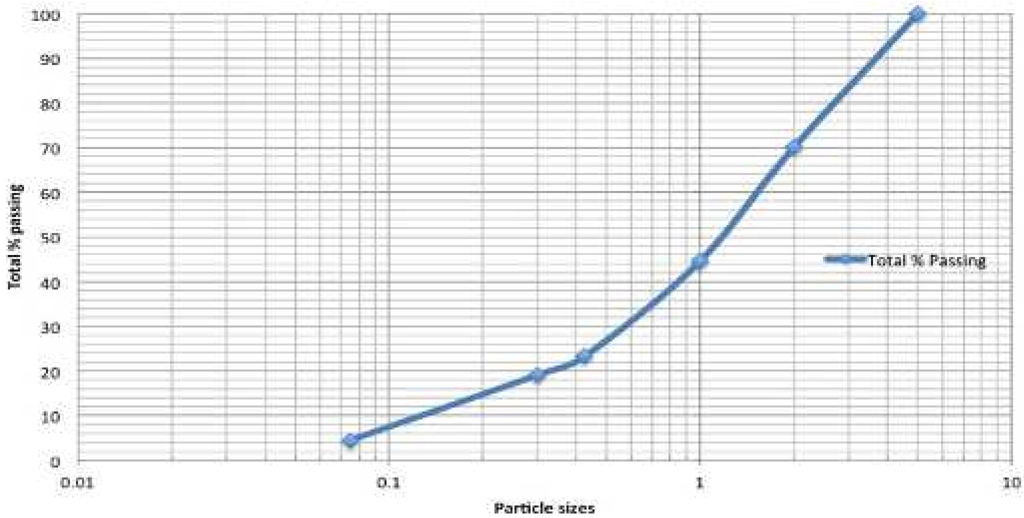


Figure 4.2: Grading curve analysis

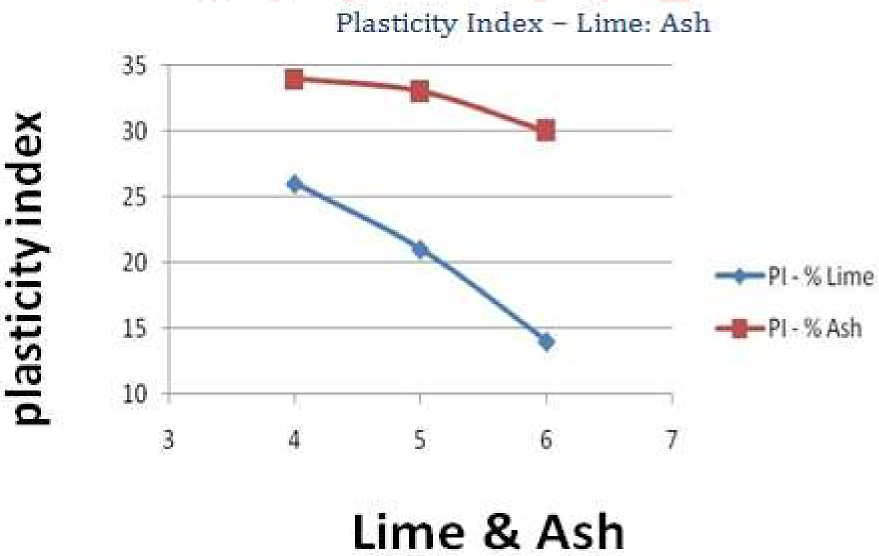


Figure 4.3: Variation of plasticity index with addition of different bagasse ashcontents

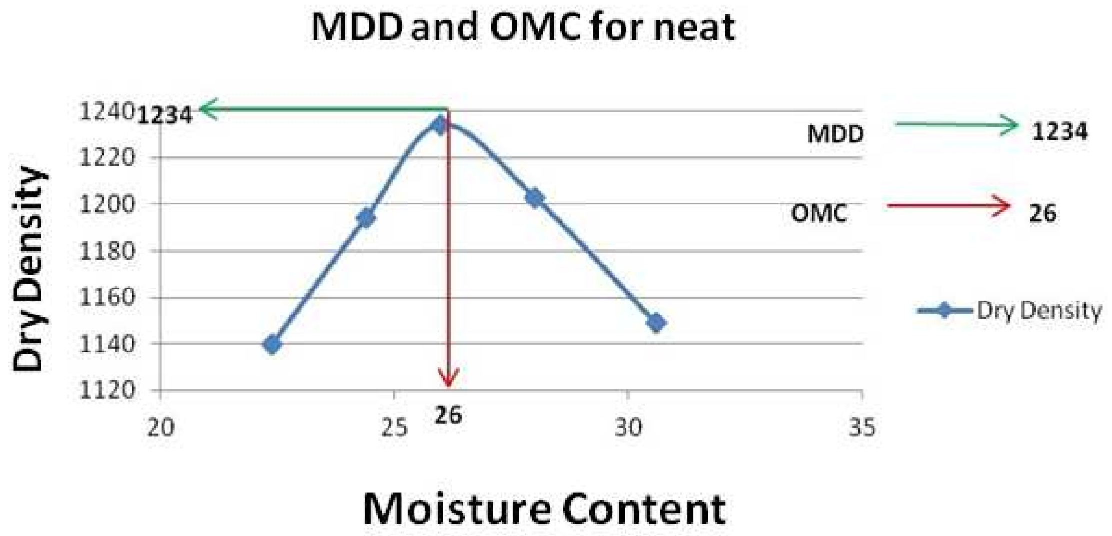


Figure 4.4 Maximum Dry Density and Optimum Moisture Content for neat sample

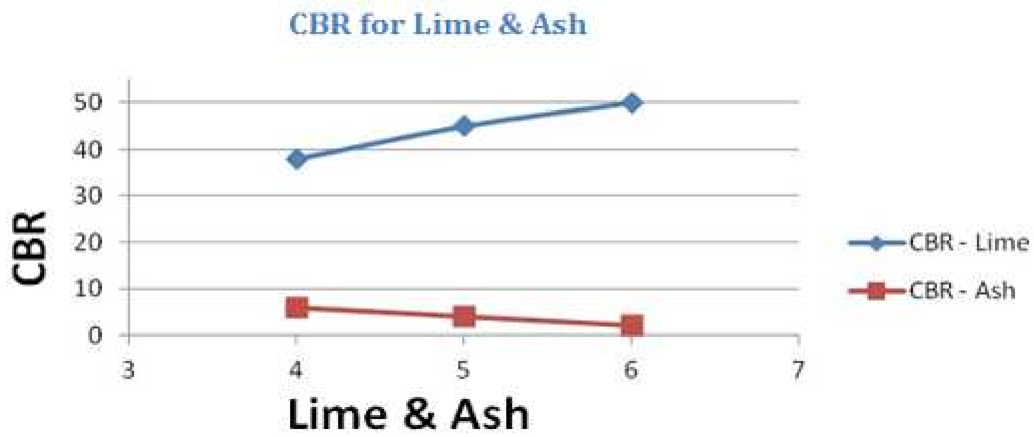


Figure 4.5: CBR of Lime and Bagasse Ash

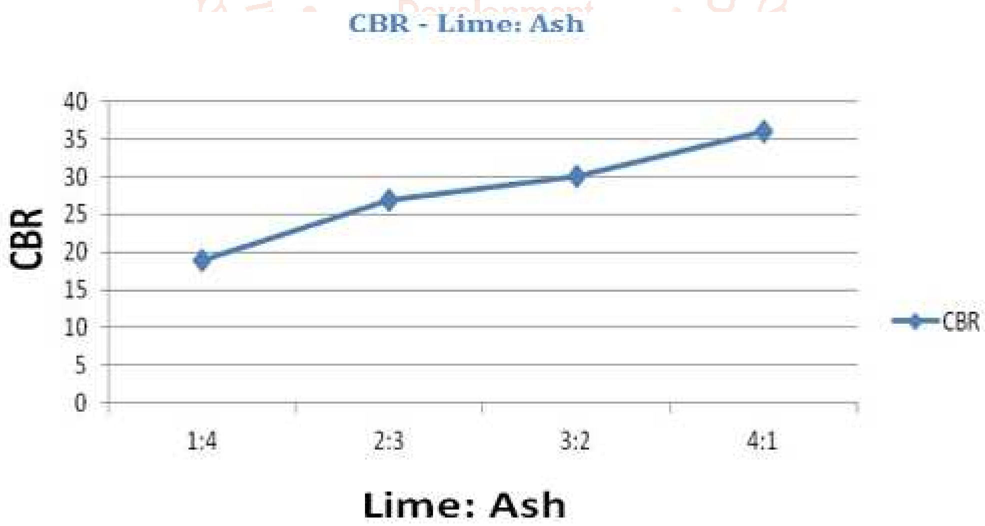


Figure 4.6: CBR for ratio of lime to ash (%)

Table 4.4: Determination of PI of 4% lime

TEST	LL	LL	LL	LL	LL	PL
No. Of blows	50	40	30	20	10	
Sample No.	C1	C2	C3	C4	C5	C6
Sample + wet soil g	37.8	39.7	41.9	43.6	45.8	20.1
Sample + dry soil g	31.5	32.6	34.1	34.9	36.2	19.8
Sample g	18.9	19.0	19.7	19.5	19.8	18.8
Water g	6.3	7.1	7.8	8.7	9.6	0.3
Dry soil g.	12.6	13.6	14.4	15.4	16.4	1.0
Moisture content %	50.0	52.2	54.0	56.6	58.5	29.6

Sample g	22.1	21.8	19.9	20.4	22.4	19.8	20.4
Water g	9.3	10.5	12.7	13.9	15.1	0.7	0.6
Dry soil g	26.1	26.3	32.0	33.4	34.8	2.7	2.1
Moisture content %	35.6	37.1	39.6	41.7	43.3	25.4	28.6

TEST	LL	LL	LL	LL	LL	PL	PL
No. Of blows	50	40	30	20	10		
Sample No.	C1	C2	C3	C4	C5	C6	C7
Sample + wet soil g	37.8	39.7	41.9	43.6	45.8	20.1	20.2
Sample + dry soil g	31.5	32.6	34.1	34.9	36.2	19.8	19.9
Sample g	18.9	19.0	19.7	19.5	19.8	18.8	18.8
Water g	6.3	7.1	7.8	8.7	9.6	0.3	0.3
Dry soil g.	12.6	13.6	14.4	15.4	16.4	1.0	1.1
Moisture content %	50.0	52.2	54.0	56.6	58.5	29.6	28.4

Table 4.5: DETERMINATION OF PI 5% LIME

TEST	LL	LL	LL	LL	LL	PL	PL
No. Of blows	50	40	30	20	10		
Sample No.	F1	F2	F3	F4	F5	F6	F7
Sample + wet soil g	54.1	52.5	58.3	58.5	62.8	22.7	23.6
Sample + dry soil g	43.9	42.8	46.9	46.0	49.4	22.1	22.8
Sample g	19.6	20.4	21.8	19.8	22.4	19.6	19.8
Water g	10.2	9.7	11.4	12.5	13.3	0.6	0.8
Dry soil g	24..3	22.4	25.1	26.2	27.0	2.5	3.0
Moisture content %	49.1	43.3	45.5	47.9	49.7	24.2	26.4

Table 4.6: DETERMINATION OF PI 6% LIME

TEST	LL	LL	LL	LL	LL	PL	PL
No. Of blows	50	40	30	20	10		
Sample No.	K1	K2	K3	K4	K5	K6	K7
Sample + wet soil g	57.5	60.6	64.6	67.7	69.3	23.2	23.0
Sample + dry soil g	48.2	50.1	51.9	53.8	54.2	22.5	22.4

VI. CONCLUSION

The following conclusions can be drawn from the results of the investigation carriedout within the scope of the study.

The chemical analysis of bagasse ash indicated that the main element were silica (66.23%), potassium (6.44%) iron (3.09%), their combined percent composition is 75.76 % which is above 70 % specified by (ASTM 2012) standards for pozzolanic reaction.

The plasticity index reduced with increased in content of bagasse ash and lime but the increment for bagasse ash was insignificant compare with the set standard by Road design manual part III. Bagasse ash alone cannot be used for expansive Black Cotton soil stabilization.

California bearing ratio increased for lime samples but reduced for bagasse ash samples and this was attributed to negligible amount of calcium present in bagasse ash. Similarly bagasse ash has negative impact on the strength of expansive Black Cotton soil hence cannot be used as standalone stabilizer. When bagasse ash partially replaced lime, plasticity index reduced and California bearing ratio increased as the ratio varies. At the ratio of 4:1 (lime:ash) the results obtained conformed with the standard set Road design manual part III of CBR 36 %, PI 20% , linear shrinkage of 9.0 and negligible swelling thus can be used for expansive Black Cotton stabilization

REFERENCES

[1] A.U. Ravi Shankar, Harsha Kumar Rai and Ramesha Mithanthaya I. (2009): “Bio-enzyme Stabilized Lateritic Soil as a Highway Material”, Journal of Indian Road Congress, Paper No. 553.

[2] Bergmann, R (2000) "Soil stabilizers on universally accessible trails". USDA Forest Service, San Dimas Technology and Development Center. Brazetti, R., and Murphy, S.R. (2000): “General usage of Bio-Enzyme stabilizers in Road Construction in Brazil”, 32nd annual meeting on paving, Brazil.

[3] C. Venkatasubramanian and G. Dhinakaran, (2011): “Effect of Bio-Enzymatic Soil

stabilization on unconfined compressive strength and california bearing ratio", Jornal of Engineering and Applied Sciences 6(5): 295-298.

[4] Chandrasekhar, B.P (2006) "A Critical review of innovative rural road construction techniques and their impacts", NRRDA, New Delhi.

[5] Dhinakaran, C. and Prasanna K.R. (2007): "Bioenzyme soil stabilization in road construction", Everyman's Science, Vol.XLI No.6, pp.397-400.

[6] Dr. K.P. Isaac, P.B. Biju and Dr. A. Veeraragavan, (2003): "Soil Stabilisation using bio-enzyme for Rural Roads", (IRC Seminar: Integrated Development of Rural and Arterial Road Networks for Socio-Economic development), New Delhi.

[7] Hitam, A. and Yusof, A. (1998): "Soil stabilizers for plantation road", Proceedings, National seminar on Mechanization in Oil Palm Plantation, Selangor, Malaysia, pp.124-138.

[8] Lacuoture, A. & Gonzalez, H. (1995). "Usage of organic enzymes for the stabilization of natural base soils and sub-bases in bagota". Pontificia Universidad Jevariana, Faculty of Engineering.

[9] Manoj Shukla, Dr. Sunil Bose and Dr. P.K. Sikdar, (2003): "Bio-Enzyme for Stabilization of Soil in Road Construction- A Cost Effective Approach", (IRC Seminar: Integrated Development of Rural and Arterial Road Networks for Socio-Economic development), New Delhi.

[10] Marasteanu, M. O., Hozalski, R., Clyne, T. R. & Velasquez, R. (2005). "Preliminary laboratory investigation of enzyme solutions as a soil stabilizer". Minnesota Department of Transportation, Research Services.

[11] Sureka Naagesh and S. Gangadhara (2010), "Swelling Properties of Bio-enzyme Treated Expansive soil". International Journal of Engineering Studies, ISSN 0975- 6469 Volume 2, Number 2 (2010), pp. 155–159.

[12] The Carbon Group, LLC. "Perma-Zyme 11x soil stabilization for road construction and natural liners".