QUALITATIVE STUDY ON PHYSICAL AND BIO-ENZYMATIC STABILISATION OF LATERITIC SOIL

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Abstract: ***Sub base is an integral part of the road pavement structure. The main functions of the sub base is to provide a stress transmitting medium to spread the surface wheel load in such a manner as to prevent shear and consolidated deformations. The number of researcher's worked on characterizing the various properties of the laterite soil and found that the problems associated with the laterite are, (a) in the majority of cases, it doesn't satisfy conventional specifications for road construction materials especially road bases. (b) It undergoes property changes during construction, gradation being considered to be the most sensitive. This paper presentation result obtained from one of the method adopted for stabilizing the laterite soil by using a Bio-Enzyme called Terrazyme. The stabilized soil strength parameters have been compared with the sand blended soil stability. The Indian Standard code of practices IS 2720 and IS 4332 (Part 1 to Part 10–2002) is used for guidelines and methodology.***

INTRODUCTION:

Transportation by road is the most important facility in moving men and material. It contributes to the economic, industrial, social and cultural development of a region or state of nation. The highways have to be maintained so that comfort, convenience and safety are provided to the traveling public. The pavement along the national and state highways in the costal belt of Karnataka is damaged severely at many locations. The damage will be more during rainy season and the main causes are poor strength of sub base and low permeability of the above causing unsatisfactory drainage of water in the soil in sub base. Hence it is necessary to have a proper diagnostic study of soil in sub base and to come out with a stabilization method.

BRIEF HISTORY ON AREA UNDER INVESTIGATION:

Puttur is a town in the Dakshina Kannada district, in the Indian state of Karnataka. It is the headquarters of the Puttur Taluk. The town is located 52 km from Mangalore, the District head quarter along the Mysore-Mangalore highway, in a hilly region between the coast and the Western Ghats. Puttur is located at 12.77°North and 75.22° east. It has an average elevation of 87 meters (285 feet) from the ocean. Puttur is the second biggest town in the District.

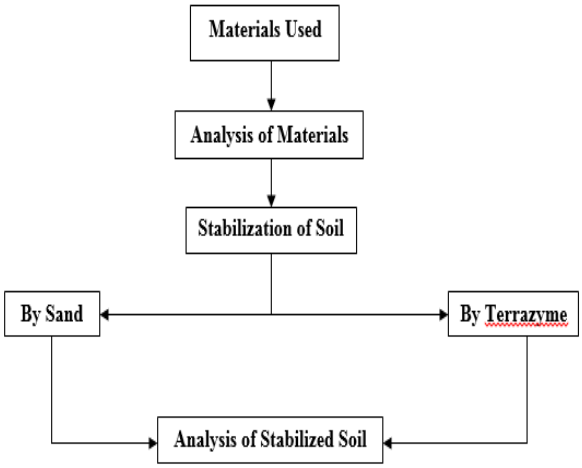
SOILS:

The main soil types in this district are laterites, shedi soil, coastal alluvium and saline soils.

PRESENT WORK:

Laterite soil was stabilised by using sand with different mix proportions and variable enzyme dosages and strength of the stabilised soil has been evaluated after curing period of one week, two weeks and four weeks. The tests were carried out to determine the consistency limits, CBR, Shear parameters by Triaxial test and permeability of the soil specimens after the stabilisation using sand and enzyme. Terrazyme named enzyme has been used for stabilisation which is manufactured in Nature Plus.Inc. USA.

MATERIALS AND METHODOLOGY:



TESTS ON LATERITIC SOIL:

The Lateritic soil obtained from the site Tenkila (Puttur) was tested in the laboratory for the properties like specific gravity, grain size distribution, consistency limits, I.S. compaction, Tri-Axial compressive strength, CBR values. As per the Indian Standard code of practices IS 2720.

TESTS ON SAND:

According to IS code description the specific gravity, gradation of the sand taken has been obtained.

STABILISATION USING TERRAZYME (BIO-ENZYME):

TerraZyme a bio-enzymatic soil Stabiliser improves the engineering properties of the locally available soil for the use of construction of roads. Both laboratory and field studies conducted in India have shown that soil stabilisation with TerraZyme provides such positive improvements in various soil types that the use of TerraZyme offers a substantial reduction in the construction cost of roads.

PHYSICAL/CHEMICAL CHARACTERISTICS:

Boiling Point: 212° F
Specific Gravity (H_2O = 1): 1.000 - 1.090
Vapor Pressure (mmHg): Same as Water
Melting Point: Liquid
Vapor Density (Air = 1): 1
Evaporation Rate (Butyl Acetate = 1): As Water
Solubility in Water: Infinite pH: 3.10 - 5.00
Appearance and Odor: Brown clear liquid; characteristic odor.

DOSAGE OF ENZYME (TERRAZYME):

Varying quantities of Stabilisers can cause different effect in the same soil sample. Insufficient quantity of Terrazyme may lead to less stabilisation of the soil whereas excess quantities may result the stabilisation ineffective and uneconomical. Hence, to determine the optimum quantity of Terrazyme for best results, CBR tests were conducted on each of the soil samples with varying quantity of Terrazyme. Depending on the soil gradation, clay content and plasticity index of the soil, the required dosage of Terrazyme for mixing with soil.

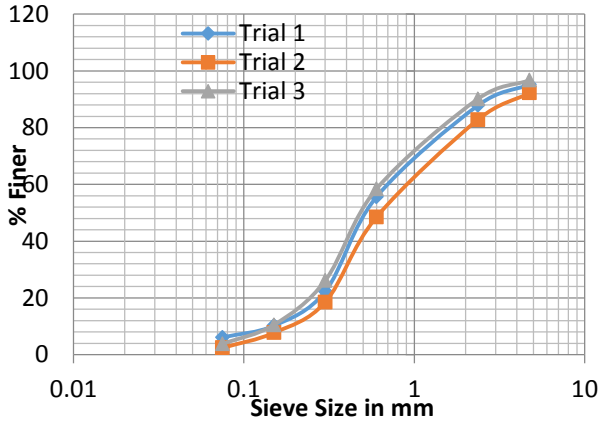
Dosage	300ml/m^3 of soil	ml/kg of soil
1	1.0	0.22
2	2.0	0.11
3	3.0	0.074

TESTS ON LATERITIC SOIL:

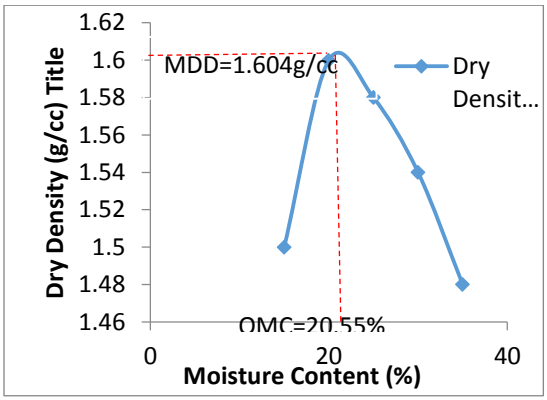
The test results on Lateritic soil were presented in the table below; the relationships for grain size distribution, I.S. heavy compaction are shown in Graphs.

Properties of Lateritic Soil

Sl. No.	Property	Value
1	Specific gravity	2.61
2	Grain Size Distribution a) Co-efficient of Uniformity, C_u b) Co-efficient of Curvature, C_c	46.34 10.58
3	Consistency limits (%) Liquid limit plastic limit plasticity index	50.5 50.0 0.5
4	IS Soil Classification	SM (Silty Sand)
5	Engineering Properties I.S Heavy Compaction a) Max dry density, γ_d max b) O.M.C	1.604g/cc 20.55%
6	CBR Value (%) I.S Heavy Compaction a) OMC condition b) Soaked condition	2.41 % 2.04%
7	Tri-Axial compression test Cohesion (kg/cm^2) Angle of Friction	1.52 60.92^0



Graph: Grain size distribution curve of Lateritic soil



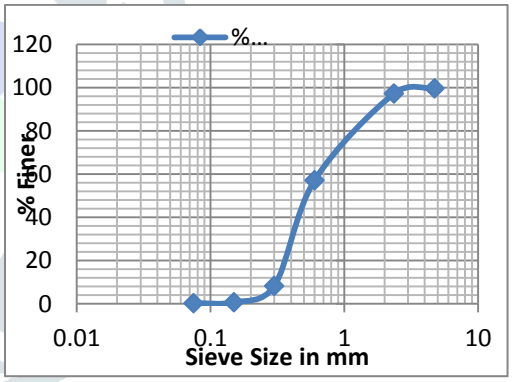
Graph: Heavy Compaction characteristics of Lateritic soil

TESTS ON SAND:

The test results on the locally available sand were presented in Table. The grain size distribution curve is shown in Graph. From the Graph, it can be seen that more than 50 percent of partials are retained on 75 micron I.S. sieve. Coefficient of uniformity (Cu) and coefficient of curvature (Cc) were found out to be 2 and 0.83 respectively. Based on the test results, sand is classified as Poorly Graded Sand (SP).

Table: Properties of sand

Description	Test value
Specific gravity	2.64
Fineness modulus	2.18
Grading as per IS: 383-1970	Zone-II

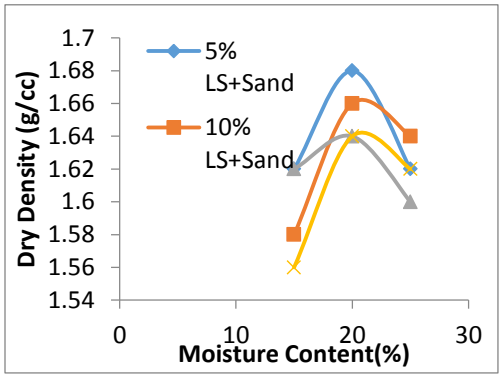


Graph: Grain size distribution curve of locally available sand

TESTS ON BLENDING LATERITIC SOIL – SAND:

When the soil is mixed with the soil in 5%, 10%, 15% and 20% of the total soil mass the results obtained are tabulated in the table. The increase in the CBR value has been increased for the mix of 10% of the soil mass. For soaked condition the CBR value was found to be 6.71%.

COMPACTION TESTS:

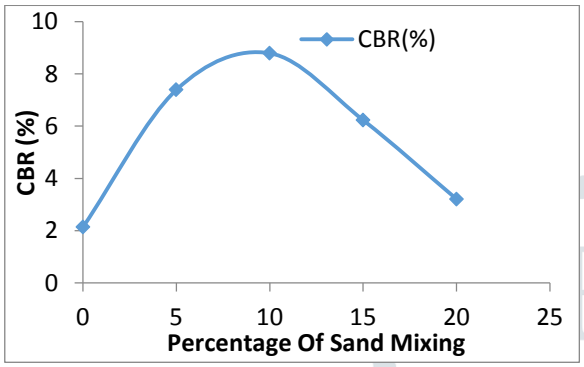


Graph: Compaction curves of Blended soil

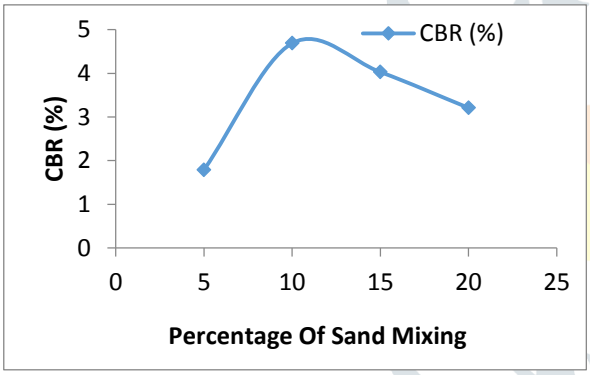
CBR TESTS:

Table: Compaction and CBR Test Results on Lateritic Soil and Sand Blended Mixes

Lateritic soil (%)	Sand (%)	O.M.C (%)	MDD (g/cc)	CBR (%)	
				At OMC	Soaked
100	0	20.55	1.62	2.14	2.04
95	5	20	1.68	7.39	1.89
90	10	20	1.66	8.79	6.71
85	15	20	1.64	6.23	1.60
80	20	20	1.66	3.21	1.46



Graph: Variation in CBR values of Blended soil (At OMC)



Graph: Variation in CBR values of Blended soil (Soaked)

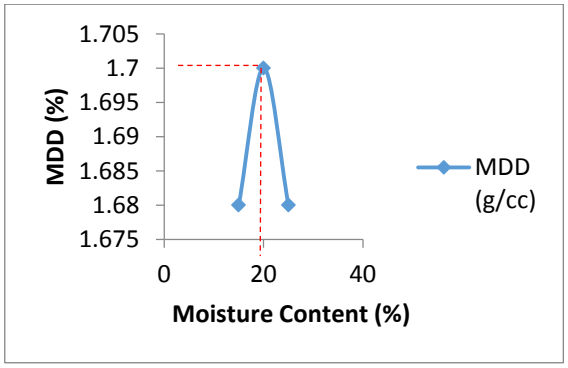
TESTS ON ENZYME TREATED LATERITIC SOIL:

The three variable enzyme dosages were used for stabilize the Lateritic soil. The various tests had been carried out and the values are tabulated and graphs are plotted according to them.

COMPACTION TEST:

Table Compaction Test Results

Moisture Content (%)	15	20	25
MDD (g/cc)	1.68	1.7	1.68

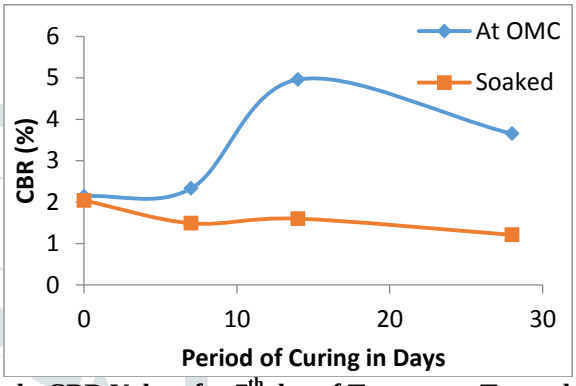


Graph: Compaction Curve for Enzyme Treated Soil

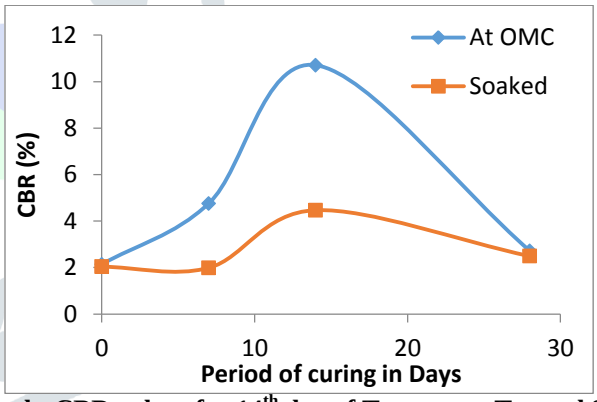
CALIFORNIA BEARING RATIO TESTS:

Table: CBR values of soil treated with Enzyme

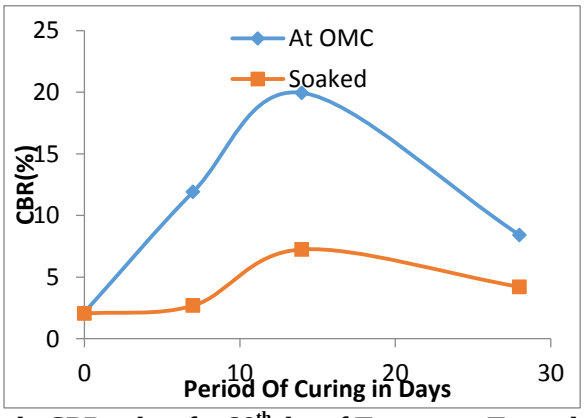
Dosage		CBR	
		At OMC	Soaked
Untreated Soil		2.14	2.04
1	7th Day	2.33	1.49
	14th Day	4.76	1.99
	28th Day	11.92	2.69
2	7th Day	4.96	1.60
	14th Day	10.71	4.47
	28th Day	19.95	7.25
3	7th Day	3.65	1.21
	14th Day	2.72	2.49
	28th Day	8.418	4.21



Graph: CBR Values for 7th day of Terrazyme Treated Soil



Graph: CBR values for 14th day of Terrazyme Treated Soil



Graph: CBR values for 28th day of Terrazyme Treated Soil

From the table it is evident that there is gradual improvement in the CBR values of treated soil when compared with untreated one, as period of curing increases the rate of improvement in CBR values also increases. Results shows that highest quantity of enzyme i.e., dosage 3 improves the CBR values to a higher range. CBR value of

untreated soil is found to be 2.14 % where the CBR value of enzyme treated soil after 4 weeks of curing is found to be 19.95 % at OMC.

TRI-AXIAL STRENGTH TESTS:

Tri-Axial strength of Lateritic soil was evaluated by stabilization with variable dosages of enzyme for one, two and four curing weeks. The specimens were prepared and kept in thermacol box to retain moisture of the sample so that reaction between soil particle and Terrazyme may be continued. The test results have been given in Table and values are plotted and shown in Graph.

Table Tri-Axial strength (Cohesion) of soil with Enzyme

Dosage	7th Day	14th Day	28th Day
Un Treated	1.52		
1	3.37	4.74	6.15
2	0.986	1.604	2.34
3	1.32	2.366	3.47

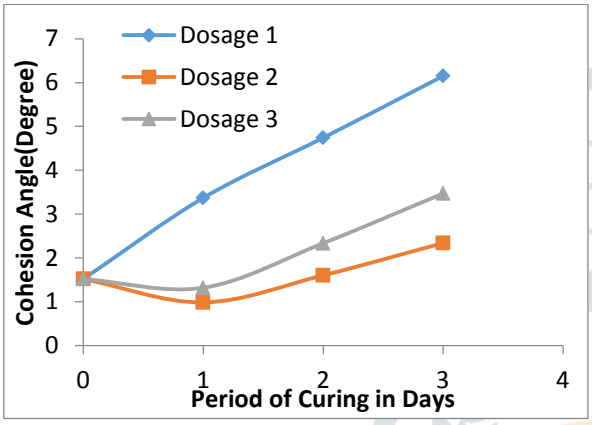


Fig: Variation in Tri-Axial strength (Cohesion) of treated soils

CONCLUSIONS:

1. Bio-Enzyme Stabilisation has shown medium improvement in physical properties of local laterite soil. This improvement may be due to chemical constituent of the soil which has low reactivity with Bio-Enzyme, therefore it is advisable to first examine the effect of Bio-Enzyme on soil Stabilisation in the laboratory before actual field trials.
2. The laterite soil properties have been much improved by Stabilising with enzyme dosage of 300ml/ $2m^3$ of soil.
3. Enzyme is found to be ineffective for improving consistency limits.
4. The CBR value of laterite soil increased by 9 times compared to its natural CBR value after four weeks of curing for a dosage of 300ml/ $2m^3$ of soil. CBR values improved gradually during the curing period.
5. The Tri-Axial compressive strength test of the soil gives the cohesion increased by 4 times after four weeks of curing for a dosage of 300ml/ $2m^3$ of soil.
6. The laterite soil properties have been improved by adding sand. For 10% of sand blending the CBR value has increased by 4 times its original CBR value. It is observed that CBR value decreases with increase in percentage of sand.
7. The CBR values of the enzyme treated soil decreases with increase in the concentration of enzyme mix.
8. By comparing CBR values of the different dosage of terrazyme mixed soil it is observed that the enzyme Stabilisation for the silty sand soil gives better improvement in the CBR value.

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