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Stabilization of soil as highway material using Terrazyme as Bio-enzyme

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Abstract - *Engineers often face problem related to soil properties like its bearing capacity. Sometimes engineers face problem that the project site isn't capable of retaining the load of the structure, either at the time of building the structure or after construction or during lifespan of the structure. To deal with such a problem soil stabilization is done or to enhance the property of soil for safety of structure and to increase bearing capacity. To deal with these problems in ecological, eco-friendly and cost-effective way soil stabilization with bio-enzyme is applied. As the conventional soil stabilization done by Gravel, sand etc. are not very much effective and is costly now a days. Recently many bio-enzymes have been tested and used for soil stabilization economically. Terrazyme is one such bio-enzyme which has been used in the present project to determine its impact on CBR values and consistency limits of soil. It has been found that Terrazyme treated soil shows significant increase in the consistency limits and CBR values with the longer curing period.*

Key Words: **Bearing capacity, soil stabilization, cost effective, cost effective, bio-enzyme, Terrazyme, etc.**

1. INTRODUCTION

Soil stabilization is a process in which soils weak in its engineering properties are strengthened by mechanical, physical, biological, chemical or combined method. One of these methods are used for changing the properties of a natural soil to meet strength requirement. This helps to acquire the desired property of soil which is very important for the serviceability of the structure. Soil stabilisation methods improve the load supporting capacity and overall performance of in-situ subsoil including sands, agricultural soil and construction and demolition waste materials, used as highway construction materials.

There are various method of soil stabilisation: mechanical, Compaction, Chemical stabilisation

1.1 Chemical stabilization:

There are certain chemicals which are which are mixed with soil to enhance the properties whenever a certain quantity of such chemical is applied. Due to chemical reaction soil gain required properties.

1.2 Bio-enzyme:

A bio-enzyme is an organic catalyst formulated by vegetable extracts that speeds up a chemical reaction, that otherwise would happen at much slower rate, without becoming a part of the end product. They are usually sprayed on the surface to increase the strength of the structure. Soils need to be stabilized to increase strength and durability or soils may also need to be stabilized to check dust generation and erosion.

There are various types of Bio-enzymes; renolyth, acidic and alkaline bio- enzyme, terrazyme, permazyme 11 -x

1.3 Terrazyme:

Terrazyme is an organic catalyst which is natural, non-toxic, non-corrosive and non-flammable liquid, produced by formulating vegetable extracts. Organic enzymes come in liquid form. Terrazyme is used as an additive to the soil. The working mechanism of terrazyme is that it replaces adsorbed water with organic cations, thus neutralizing the negative charge on a clay particle. Thus, it reduces the tendency of some clays to swell.

1.4 Mechanism of Soil Stabilization by Bio-enzyme:

Engineering properties of the soil are altered when terrazyme added water is mixed with soil. The change in properties of soil depends upon the type of soil and amount of dosage of enzyme. These bio enzymes stabilize the soil by reducing the voids between soil particles and minimizing the absorbed water in the soil for maximum compaction.

For stabilization purpose we use terrazyme in different doses and test the soil property.

1.5 Application of different Dosages of terrazyme with different curing period:

Firstly, we apply **1 m^3**= 200 ml = **0.099 ml/kg** of terrazyme on the soil sample with 0, 7, 14, 21 days curing and then check the parameters.

Then applying **0.5 m^3**=200 ml = **0.199 ml/kg** of terrazyme on the soil sample with 0, 7, 14, 21 days curing and then check the parameters.

Similarly applying **0.25 m³**= 200 ml = **0.398ml/kg** of terrazyme in the soil sample and note down the parameters of different percentages.

2. MATERIALS AND METHODS

The materials used in our project are mentioned below: -

2.1 Soil sample

We use brown agriculture soil for testing purpose. We take about 40 kg of soil from the project site for the stabilization property. We pass the soil with 20 mm sieve and take the sample for the test purpose. We find out the specific gravity of the soil sample which is further used for determination of doses of terrazyme. We conduct CBR test and proctor test on the soil sample.

2.2 Terrazyme-

Terrazyme is an organic product formulated by vegetable extracts. It is a natural, non-toxic, non-corrosive and non-inflammable material which comes in liquid form. They are perfectly water soluble and brown in colour. By their action on the soils these enzymes, the voids between soil particles are reduced and absorbed water in the soil required for maximum compaction is minimized.

Table-1: Properties of Terrazyme

S.No	Property	Value
1.	Specific gravity	1.000-1.090
2.	pH value	3.10-5.00
3.	Appearance	Liqiud
4.	Odour	Characteristic odour
5.	Flammability	Inflammable
6.	Solubility	Infinite
7.	Colour	Brown

3. EXPERIMENTS AND OBSERVATIONS

3.1 California Bearing Ratio of untreated soil sample [9]

Table-2 Standard Load and Penetration

Penetration(mm)	Load (kg)
2.5 mm	1370 kg
5.0 mm	2055 kg

CBR = (Test Load / Standard Load) X 100

Following chart gives the result of CBR test performed on untreated soil sample:

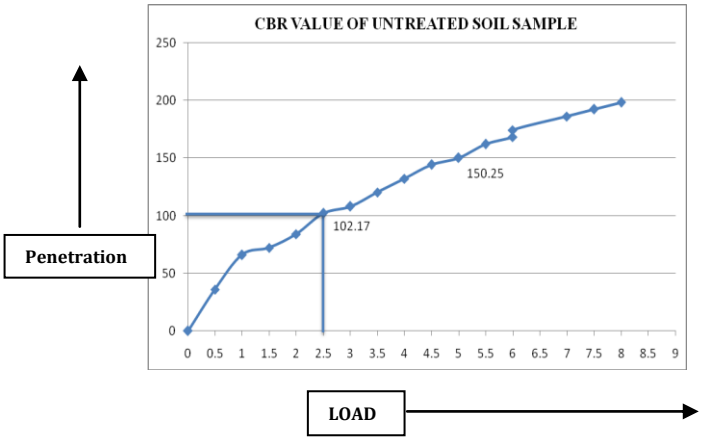

Chart 1: CBR Graphs of untreated soil sample

CBR Value at - 2.5mm = 7.45%
5.0mm = 7.31%

3.2 Effect of curing:

a. Application of first Dose

Firstly we apply **1 m³**= 200 ml =**0.099 ml/kg** of terrazyme on the soil sample with 0, 7, 14, 21 days curing.

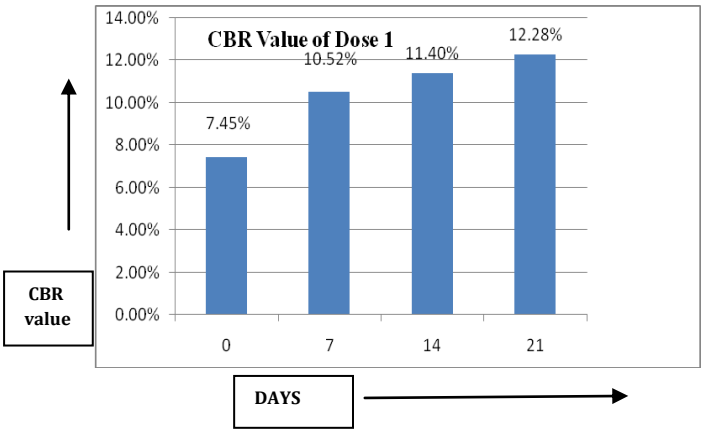

Chart 2: CBR Graph after first dose

Secondly by applying **0.5 m³**=200 ml = **0.199 ml/kg** of terrazyme on the soil sample with 0,7,14,21 days curing and then check the parameters.

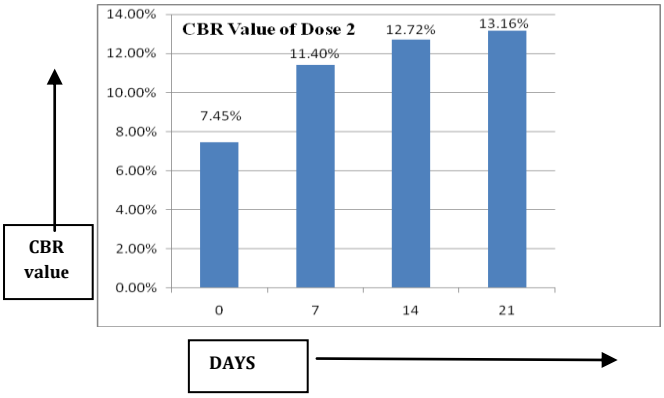

Chart 3: CBR Graphs after second dose

By applying **0.25 m³**= 200 ml = **0.398ml/kg** of terrazyme in the soil sample with 0,7,14,21 days curing and check the parameters

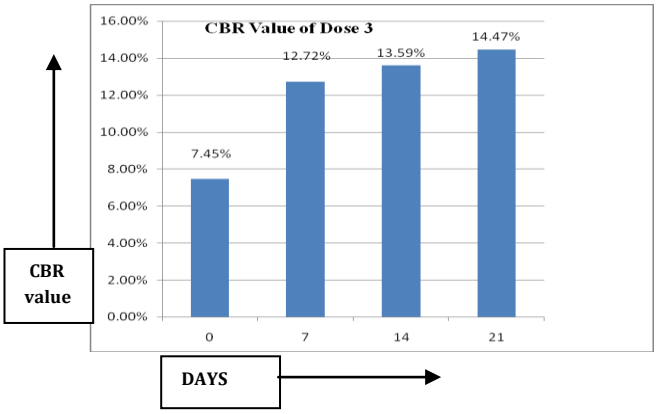

Chart 4: CBR Graphs after third dose

3.3 Combined Effect on CBR of Dose and curing:

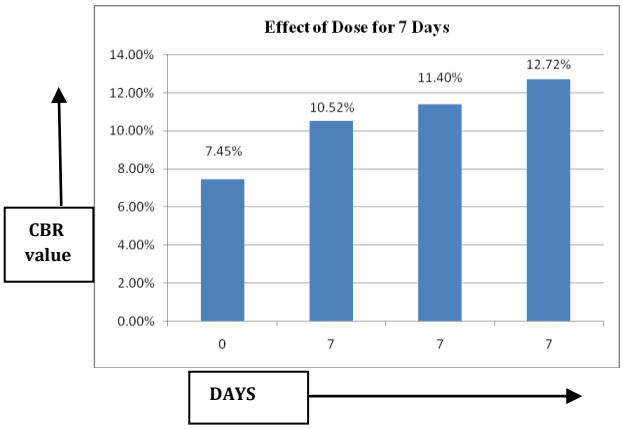

Chart 5: CBR Graphs after 7 days under first, second and third dose

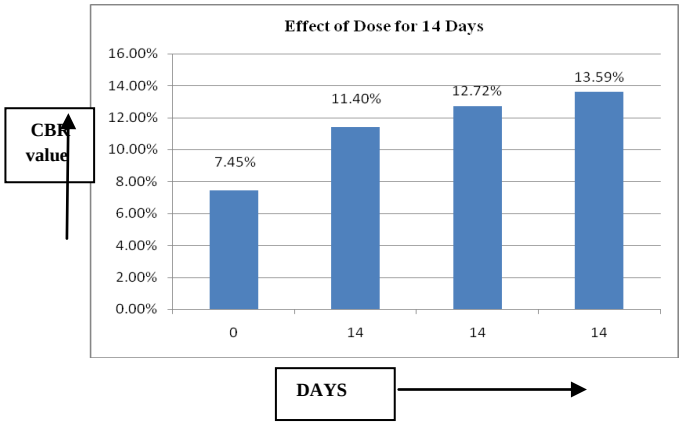

Chart 6: CBR Graphs after 14 days under first, second and third dose

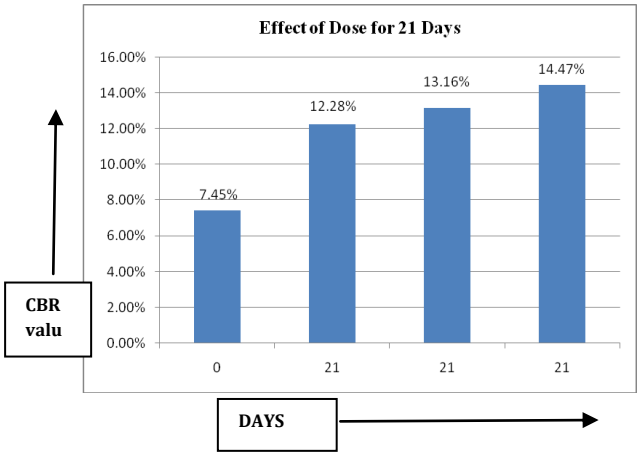

Chart 7: CBR Graphs after 21 days under first, second and third dose

3.4 Liquid limit[10]

Liquid Limit of untreated soil sample.

Table-3: Observations of LL

S.No	Sample 1	Sample 2	Sample 3
1.	W1 = 44 gm	42gm	46gm
2.	W2 = 156gm	134gm	146gm
3.	W3 = 144gm	118gm	128gm
4.	35 round	28 round	15 round
M/S content	12%	21.05%	21.95%

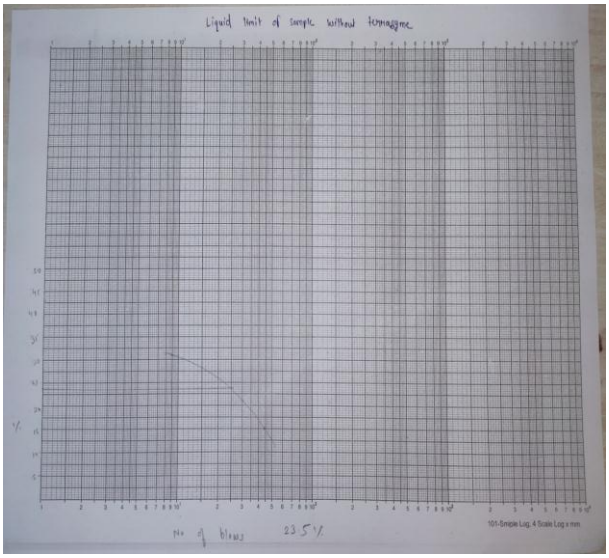

Chart 8: Graph for LL of sample

Liquid Limit of soil sample = 23.5%

3.5 Effect of Curing on Liquid Limit under different doses:

Following graphs shows liquid Limit of soil samples with different Doses afer 7, 14, 21 Days curing

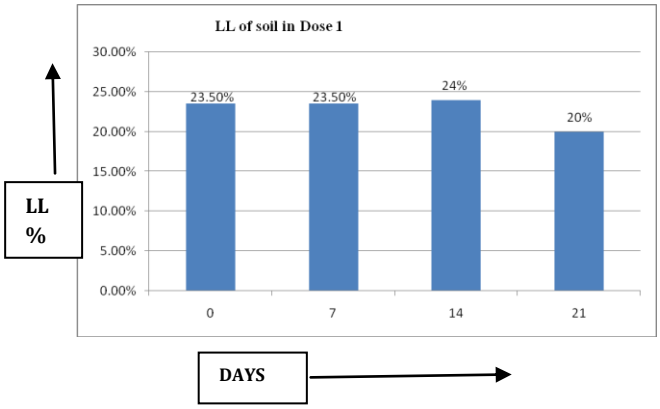

Chart 9: Liquid Limit of sample with dose 1 after 7, 14, 21 days curing

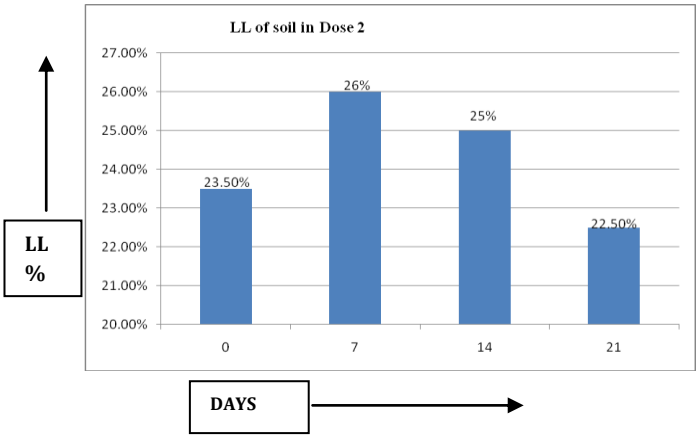

Chart 10: Liquid Limit of sample with dose 2 after 7, 14, 21 days curing

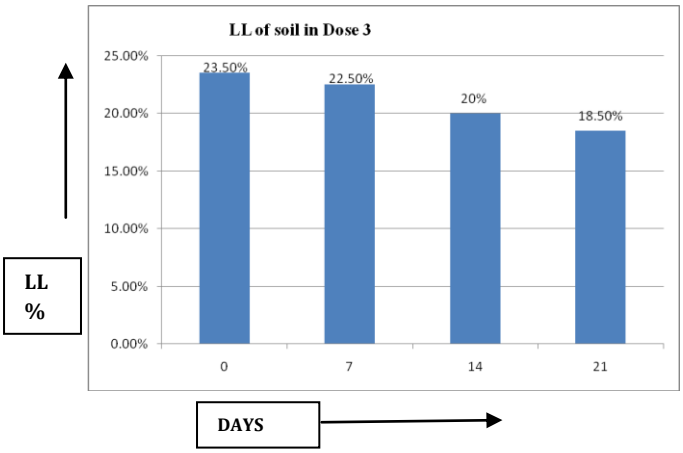

Chart 11: Liquid Limit of sample with dose 3 after 7, 14, 21 days curing

3.6 Combined Effect on LL of Doses and different days of curing:

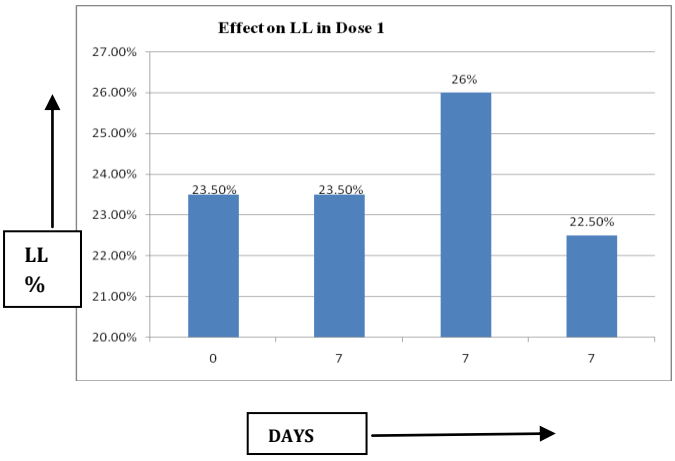

Chart 12: LL Graphs after 7 days under first, second and third dose

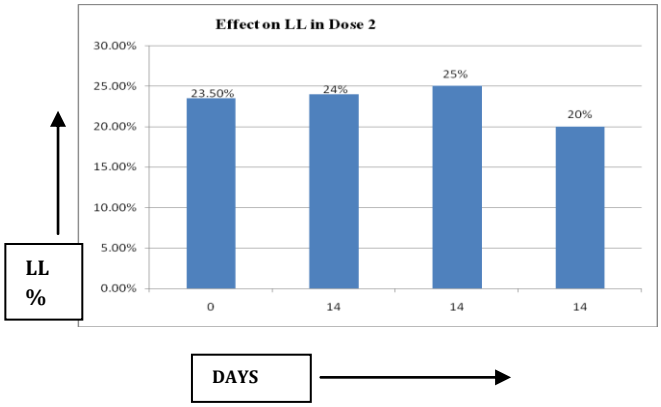

Chart 13: LL Graphs after 14 days under first, second and third dose

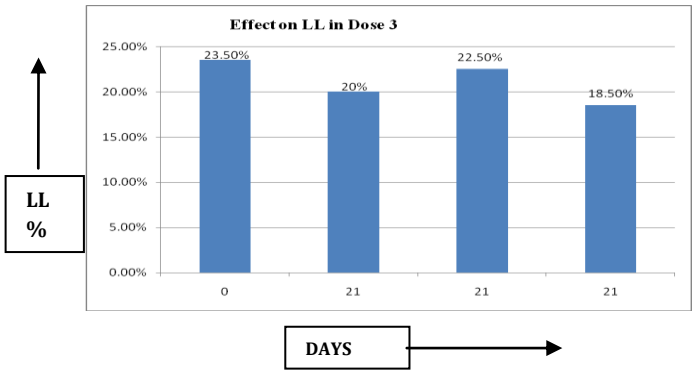

Chart 14: LL Graphs after 21 days under first, second and third dose

4. RESULTS

4.1 CBR Test:

In first dose**1 m³**= 200 ml =**0.099 ml/kg**

CBR values increase from 7.45% in zero dose and no curing to 10.52%, 11.40%, 12.28% in 7, 14, 21 days curing. This indicates that our doses work properly and increases the load bearing capacity.

In Second dose **0.5 m³**=200 ml = **0.199 ml/kg**

CBR values increase from 7.45% in zero dose and no curing to 11.40%, 12.72%, 13.16% in 7, 14, 21 days curing. This indicates that our doses work properly and increases the load bearing capacity.

In third dose **0.25 m³**= 200 ml = **0.398ml/kg**

CBR values increase from 7.45% in zero dose and no curing to 12.72%, 13.59, 14.47% in 7, 14, 21 days curing. This indicates that our doses work properly and increases the load bearing capacity.

From the application of different dose, it is found that on application different dose CBR value increased continuously.

4.2 Liquid limit test:

First Dose

LL of untreated soil is 23.5% and on application of first dose become 23.50%, 24%, 20% in 7, 14, 21 days curing.

Second Dose

LL of untreated soil is 23.5% and on application of first dose become 26%, 25%, 22.50% in 7, 14, 21 days curing.

Third Dose

LL of untreated soil is 23.5% and on application of first dose become 22.50%, 20%, 18.50% in 7, 14, 21 days curing.

From the application of different dose of terrazyme it is found that the liquid limit decreases accordingly but, it is noticed that in 7 days curing of second dose sample LL increased but after this it decreases in 14 and 21 days.

In all samples on the application of dose results to decrease the LL of the soil.

5. CONCLUSION

- From comparing all the results of different doses of CBR it is found that on increasing doses on natural sample upto 0.25m³ or 0.398 ml/ kg CBR value increased according to curing days in give doses of sample.
- In natural sample CBR value is 7.45% and in third doses 14.47% in 21days which is excellent, it shows that load bearing capacity increases.
- Liquid limit of natural sample on addition of given doses keeps on decreasing.
- It shows that on increasing doses upto certain amount liquid limit decreases.
- Conclusion of project is that upto certain limit, CBR value of soil sample increases on desired dose of chemical and also, liquid limit decreases to some value on increasing certain amount of chemical.
- It is economical to use terrazyme for soil stabilisation because it proves effect results in laboratory tests.

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