Effect of Bio-Enzyme (Terrazyme) on the properties of Soil Sub-grade of Road

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ABSTRACT

Different methods can be used to strengthen the soil, but the choice of a specific technique on that individual soil. These approaches range from replacing top poor soil with strong engineering soil properties to treating local soil with specific soil-stabilizing constituents i.e., cement, coarse aggregates, fine aggregates, fine sand, lime, fly ash, rice ash etc. As the study shows, Terrazyme, a bio-enzyme emerges as a very effective soil stabilizing agent. Terrazyme is used as a soil stabilizing agent in the present study. Terrazyme brings with it other significant advantages throughout its treatment application to the soil. The biggest downside it brings with it is that expensive but, as a small dose of Terrazyme, this issue can be counteracted to a large degree by enhancing the engineering properties of the soils. In depth of review , it is summaries the effect of Terrazyme in Soil subgrade , its properties and applications. This also contains advantages and limitations of Terrazyme in subgrade soil.

Keywords: *Soil stabilizing material, lime, fly ash, terrazyme, Bio-Enzymes.*

Introduction

Soil-stabilization technique is very effective approaches for improving soil engineering assets along with lowering plan costs. An efficient soil-stabilization method's selection is important feature before constructing any pavement. The selection of method of soil-stabilization depends on the degree of soil stabilization and properties of local soil. The availability of stabilizing material also helps in the implementation of the strategy of soil stabilization. The goal of the soil stabilization is to increase its bearing capacity and workability as well as to reduce its plasticity index in order to decrease the propensity to swell and shrink that greatly affected the strength and leads to failure of the base. In fact, there are many methods to stabilize soil, such as treating with lime, cement and fly ash. Such materials pollute the atmosphere when mixing with soil and some of these materials cause contamination of the environment during their manufacturing process, so the need for an economical and environmentally friendly method to stabilize the soil is urged. Considering all the aspects of soil stabilization, some bio enzymes specifically terrazyme proves to be very cost effective and environmentally friendly soil stabilizer. This is used in very limited amounts in dilute form, with water, to treat the soil. Although it is not available locally, it is not considerable as it is used in very small transportation costs. This is produced by extracts of crops, and is non toxic in nature, non-corrosive. It increases soil quality to significant extent, with limited amount use as a stabilizer.

Table 1 : Engineering Properties of soil without Terrazyme

Sr. No.	properties	Black cotton soil(sangamner)	Black cotton soil(chandwad)	Red soil(surgana)	IS Classification
1.	Specific Gravity	2.49	2.49	2.44	IS 2720 (part III)
3.	Liquid limit	51.13	51.13	42.14	IS 2720 (part V)
4.	Plastic limit	29.53	29.54	28.69	
5.	Plasticity index	21.6	21.5	13.45	
6.	IS Soil Classification	CI	CH	CI	

7.	Compaction Characteristics Maximum Dry Density (kN/m3) Optimum Moisture Content (%)	1.8 11.05	1.8 12.56	1.63 16.92	 IS 2720 (part VII) IS 2720 (part II)
8.	Unconfined Compressive Strength (kPa)	2.28	2.68	2.30	
9.	Free swell index	43	19	25	IS 2720(part XL)

Soil with very bad engineering properties may need more Terrazyme dose relative to soil with quality engineering properties before any procedure, but total project cost would probably decrease along with decreased maintenance costs. Relative to traditional stabilization techniques, the maintenance costs of Terrazyme stabilized soil can be decreased by 50-75 per cent. By adding Terrazyme in the soil for stabilization purposes, the soil's bearing potential decreases by a considerable amount and therefore the thickness of different pavement layers may be decreased in order to minimize the project's expense. Several reports indicate that terrazyme may be used as a substitute for GSB and WMM.

Table 2 : Important properties of soil

S. No.	**Properties**	**Value**
1	Specific gravity	2.48
2	Grain-Size distribution (%) • Clay • Sand • Silt	 15 40 45
3	Consistency limits (%) ➢ L.L ➢ P.L ➢ P.I	 35 22.34 12.66
4	IS Soil Category	Silt loam
5	Engineering properties IS Light Compaction • Max. dry density (gm/cc) • OMC (%) IS Heavy Compaction • Max. dry density (gm/cc) • OMC (%)	 1.86 15.3 1.88 15.2
6	CBR Value IS Heavy Compaction • OMC values (%) • Soaked Condition (%) IS Light compaction • OMC Condition (%) • Soaked Condition (%)	 2.6 1.4 2.4 1.3

7	Un-confined compressive strength (kN/m^2)	230

Terrazyme (Bio-enzyme) as stabilizer

This is bio-enzyme that originates from fruit and vegetable extracts. This is renewable, non - toxic in its nature. This replicates the hue brunette with the fragrance of molasses. It can be easily mixed with water, and then returned to the soil for production. It lowers the voids among particles in the soil and maximizes the degree of compaction

Table 3 : Basic Properties of Terrazyme

Section A- Identity	
Identity	Terrazyme
Section B- Information of Hazardous Ingredient	
Hazardous Ingredient	None
Section C- Chemical & Physical Properties	
Appearance/Odor	Brown colored liquid with smell of molasses
Specific Gravity	1.09-1.11
Boiling Point	214 ºF
Rate of Evaporation	Similarity with water
pH value	3.15-5.00
Solubility in Water	100 %
Vapor Pressure	Similarity with water
Vapor density	1
Section D- Data of Fire & Explosion Hazard	
Flash Point	-
Extinguishing Media	Non flammable
Section E- Reactivity Data	
Stability	Stable
Hazardous By-Product or Decomposition	-
Incompatibility:	Oxidizing Agent
Hazardous Polymerization	Not Possible
Section F- Health Hazard	
Entry Routes	NA
Symptoms & Sign of Exposer	-
First Aid Procedure	Affected area should be washed
Section G- Precaution For Use & Safe Handling	
Steps to be taken in case material is released or spilled	Flush to sewage system or any disposal system

Waste Disposal Methods	Flush to any disposal system
Other Precautions	-
Section H- Control Measures	
Respiratory Protection	Not Required
Gloves Protection	Not Required
Ventilation	Normal
Other Protective Equipment & Clothing	Not Required

Mechanism of Terrazyme for soil-stabilization

In general, solid particles are accompanied by negative charged ion which makes it possible to interact with positive ion. Moisture is added to the soil to have sufficient moisture quality and achieve a high degree of compaction. Such ingested water includes metal ions that are positively charged and bound to the negatively charged particles surrounding the sample, thereby creating dense clouds of needed to balanced soil particles, resulting in an rise in the soil's void ratio, which in effect imparts low compaction rates. In this case, terrazyme can be shown to be very efficient in decreasing the void ratio by minimizing the electrical charge on the water molecule, resulting in a decrease in the thickness of the water layer over the sample, thereby decreasing the void and compacting the soil with less effort to a higher degree. The following figure illustrates Terrazyme's simple and general mechanism for reducing the thickness of water layer over the soil particle.

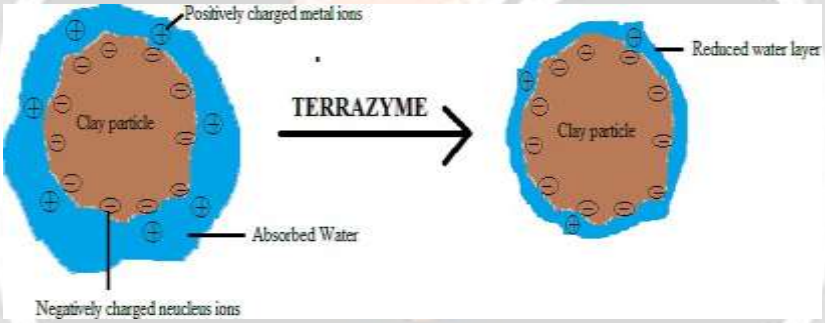


Fig 1 : Mechanism of Terrazyme

Terrazyme causes portland cement compound formation as is seen in the following reaction:

California Bearing Ratio

California Bearing Ratio is a measure focused on the penetration theory for determining field and surface mechanical power. As per the IS standard for roadway architecture, the minimum quality of the subgrade CBR should be 8 but it is very challenging for road building to provide this value in natural terrain. The subgrade is handled with Terrazyme throughout the present analysis to increase the CBR performance and the same could be seen in the chart below. This can be seen in the table, the CBR value decreases with such an rise in the Terrazyme dosage but its value continues to decline after a given dose. For light compaction, the CBR value of the unsoaked specimen rises by 100% at an appropriate dosage from 2.7 to 5.3. At optimum dose, the value of 0.80ml/5kg and soaked CBR increases by 112.5 percent from 1.6 to 3.4. Of extreme compaction, the CBR value of the unsoaked specimen rises by 96.55 per cent from 2.9 to 5.7 and the soaked CBR value rises by 105.8 per cent from 1.7 to 3.5 at an ideal dosage of 0.80ml/5 kg.

Table 4 : CBR (IS Light compaction) tests results

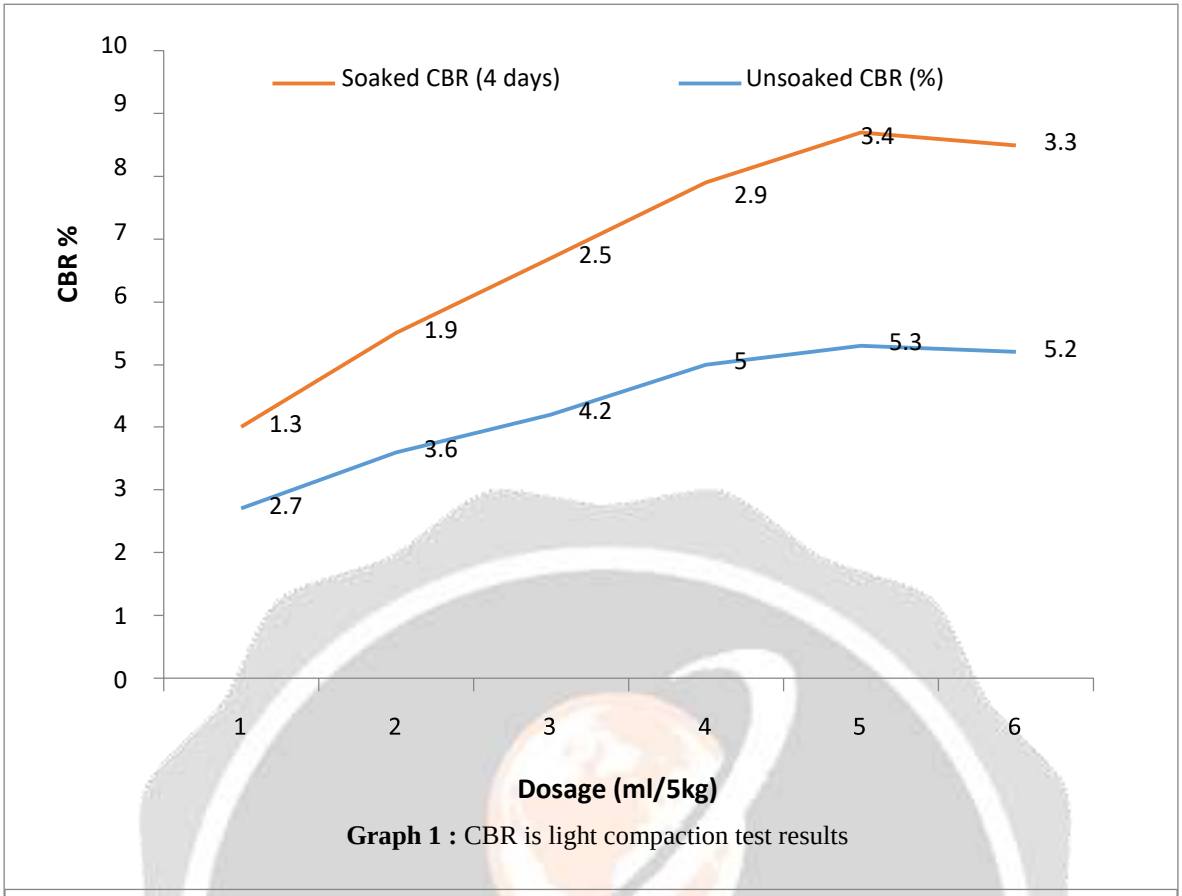
S. No.	Dosage (ml/5kg)	Unsoaked CBR (%)	Soaked CBR (4 days)
1	0.00	2.7	1.3
2	0.20	3.6	1.9
3	0.40	4.2	2.5
4	0.60	5.0	2.9
5	0.80	5.3	3.4
6	1.00	5.2	3.3

Table 5 : CBR (IS Heavy compaction) tests results

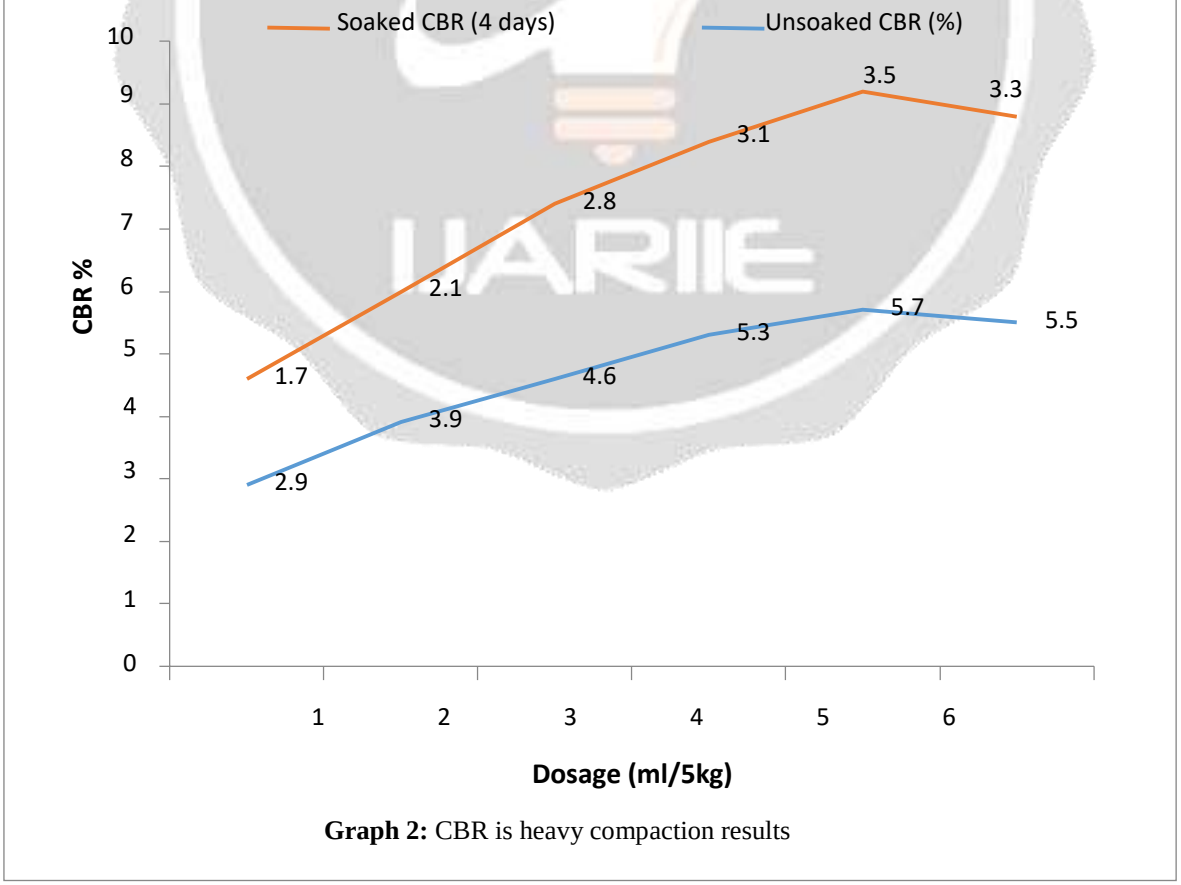
S. No.	Dosage (ml/5kg)	Unsoaked CBR (%)	Soaked CBR (4 days)
1	0.00	2.9	1.7
2	0.20	3.9	2.1
3	0.40	4.6	2.8
4	0.60	5.3	3.1
5	0.80	5.7	3.5
6	1.00	5.5	3.3

The explanation for the initial rise in CBR is that, the with introduction of Terrazyme to the soil , soil particles are compacted to a higher degree due to a decrease in the water surrounding the soil structure resulting in an decreased CBR

value, But the drug of Terrazyme tends to increase even farther well beyond optimum dose it starts to lose its efficacy in even more compacting the soil after maximum compaction is achieved but there is a little interruption in the packaging of the soil particle that also shows a small reduction in the CBR value over a certain dosages point.



Graph 1 : CBR is light compaction test results



Graph 2: CBR is heavy compaction results

Compaction test

The compaction test is carried out to establish the optimal moisture content and overall dry density of each soil type. Before compacting it, it would be very crucial to

Table 6 : Compaction Test (IS Light compaction) results

S. No.	Dosage (ml/5kg)	MDD (g/cc)	OMC (%)
1	0.00	1.82	15.0
2	0.20	1.85	14.8
3	0.40	1.87	14.6
4	0.60	1.88	14.5
5	0.80	1.90	14.4
6	1.00	1.89	14.7
7	1.50	1.83	14.9
8	2.0	1.81	15.0

Table 7 : Compaction test (IS Heavy compaction) results

S.no.	Dosage(ml/5kg)	MDD (g/cc)	OMC (%)
1	0.00	1.84	14.9
2	0.20	1.85	14.8
3	0.40	1.89	14.6
4	0.60	1.90	14.5
5	0.80	1.92	14.2
6	1.00	1.88	14.7
7	1.50	1.86	14.6
8	2.00	1.85	14.9

Scanning electron microscope(SEM)

To have the microscopic representation of the sample and also the structure of the substance, the scanning electron microscope examination is performed. Internal structure could be seen directly in the SEM-generated image. Image in SEM is not generated mainly but is produced by SEM bombarded Backscattered electron (BSE) and Secondary Electron (SE) on the content. Comparison and light differentiate between the chemical structure and topographical characteristics. Chemical composition produces specific atomic numbers which will be expressed in the picture generated by SEM as different brightness value. The SEM picture below is provided of the managed soil and soil tested with Terrazyme at optimal dosage. The pictures display physical aspect and chemical structure.

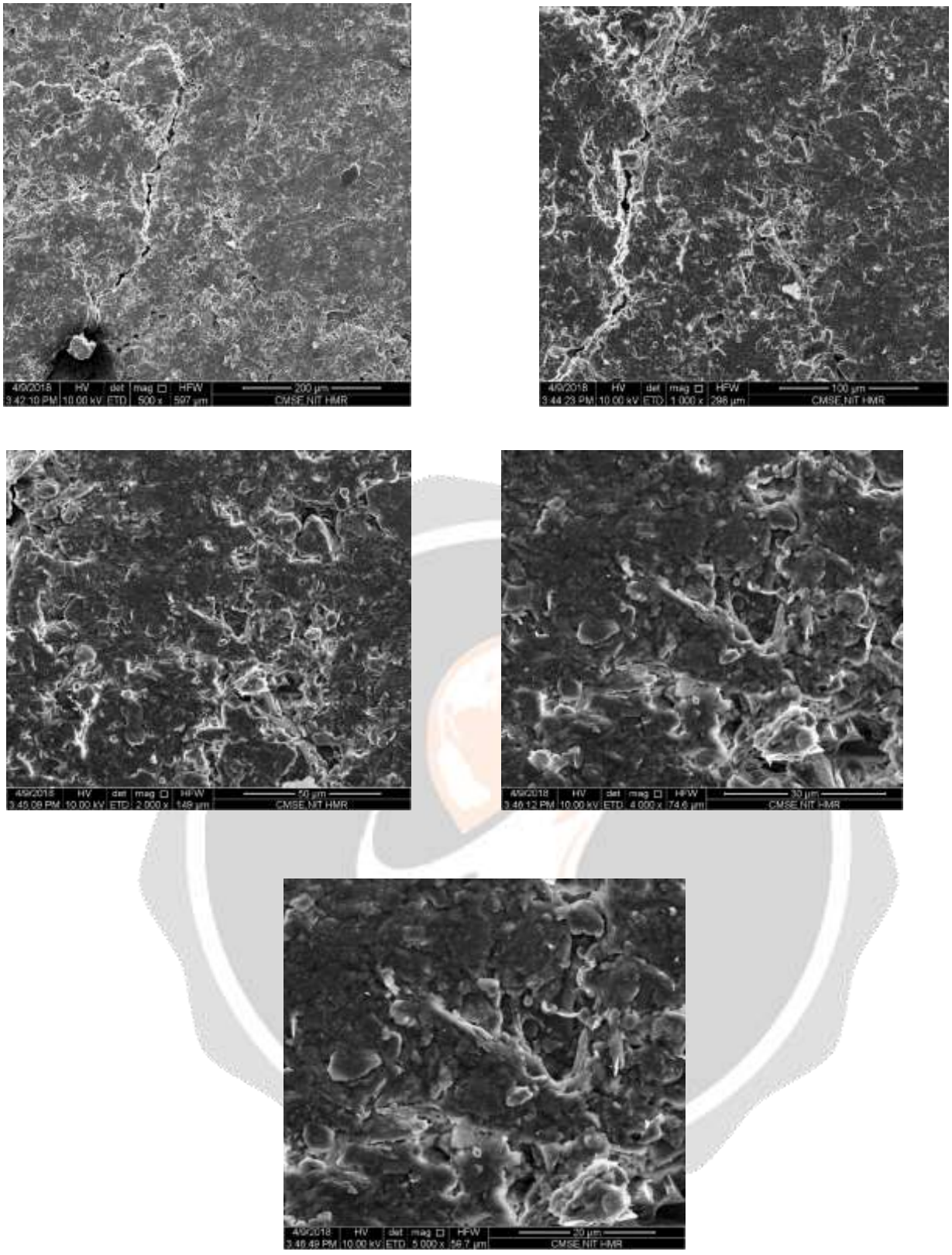


Fig. 2: SEM images of untreated soil

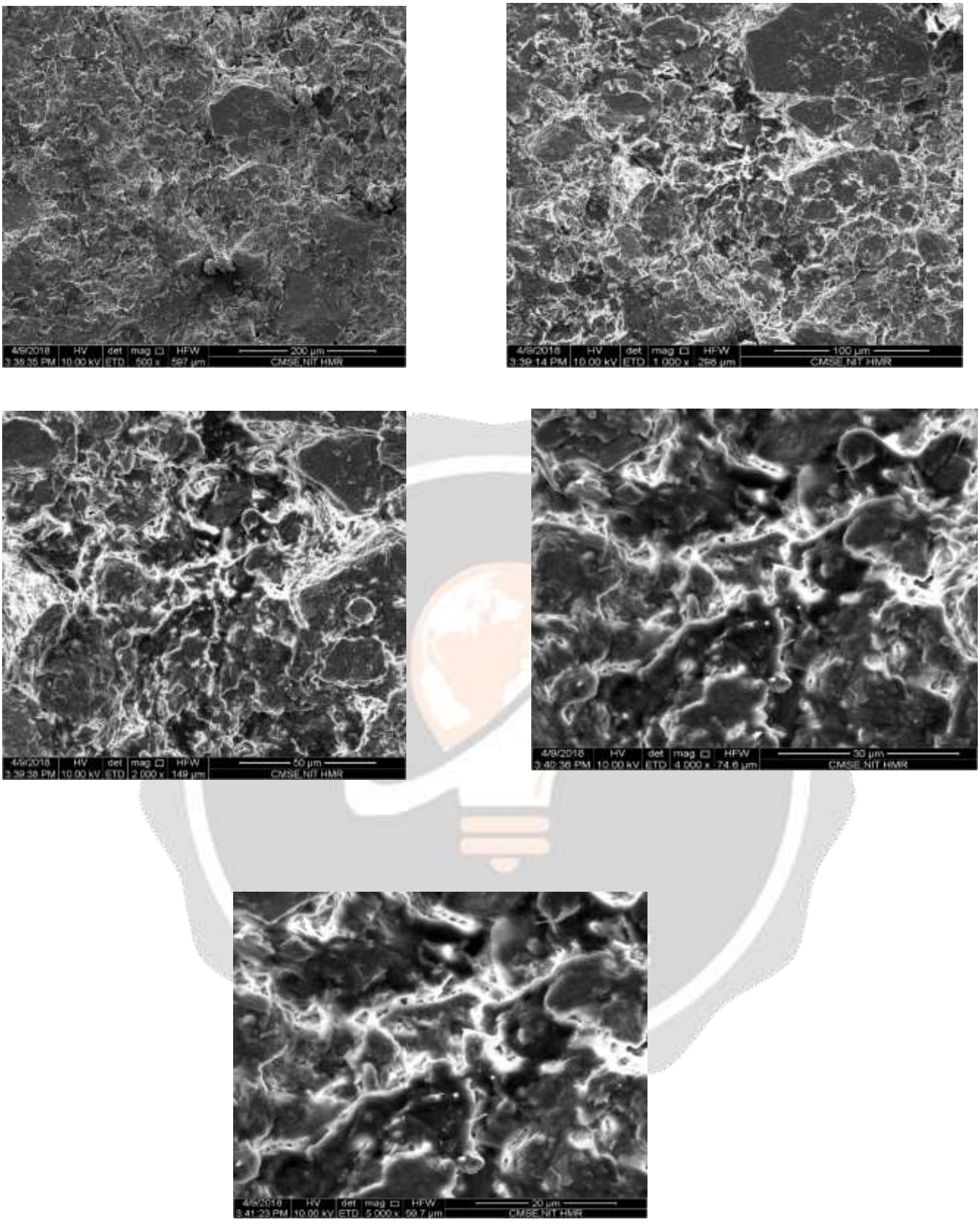


Fig. 3: SEM images of treated soil

Advantages of using Terrazyme

Terrazyme's principal benefit is its cost saving feature. This cut building expenses up to 40% relative to traditional road development activity and often decreases repair costs up to 75% based on the parent property of natural resources.

- Eco-friendly-as it is non-toxic and non-corrosive, not detrimental to humans and animals
- Cost-effectiveness- is attributed to the limited volume needed for soil care, even though it is costly.
- Simple handling- because it is non-toxic and needed in limited amounts, making it easier to manage.
- Durability-results of soil materials are irreversible, meaning that it is stable.
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Limitations of using Terrazyme

- **Availability**, Since the Terrazyme production method requires complicated activity and there are very few Terrazyme producers worldwide, it takes time to get it from the supplier.
- **Uniformly Application**, since a relatively limited amount of the use terrazyme to maintain the soil in a diluted manner, it is important to disperse it uniformly across the appropriate area so as to avoid material wastage and to maximize the intensity uniformly.
- **Affinity to Clay to Produce Results**, Researchers know that Terrazyme interacts with clay, so the effects of Terrazyme treated soil must be at least 15 per cent clay in the soil. As we know, Terrazyme interacts with clay, so the effects of Terrazyme treated soil must be at least 15 per cent clay in the soil.

Applications of Terrazyme

This may be used in the field of soil stabilisation

- Highlights
- Bridges in the works
- Subgrade upgrades
- All rural conditions
- Yard and parking lots
- Basis floors
- Within municipal highways
- Closing of reservoirs and discharges
- Clear shoulder
- Highway operation
- Emergency motorway link.

Conclusion

Its study deal with the inference drawn in the present research from analysis carried out. Reports of most of the experiment performed in this study research are examined and interpreted, and in this segment are given a proper finding based on the interpretation of the tests. By the end of the research thesis the goals listed in the very first chapter are held in view but all the goals described are met according to the end covered in this section. Terrazyme worked successfully in subgrade soil stabilization as it raised the soil CBR value by approximately 109.15 per cent. For a healthy soil subgrade, Terrazyme has been shown to be successful because it decreases the soil plasticity index resulting in lower volume shifts as the water content increases. Terr Soil treated terrazyme demonstrated an improved value of Unconfined Compressive Power in the test outcome and an rise of about 37 per cent in UCS. Terrazyme has decreased the Average Dry Soil Density and reduced the Optimal Moisture Content resulting in higher compaction rates and therefore higher intensity. Terrazyme's optimal dosage for the soil used in this analysis is 0.80ml/5 kg because this dosage produce better effects. As being one of the goals of this research was to minimize pavement thickness using Terrazyme, it is hypothesized that pavement thickness can be reduced by stabilizing soil by Terrazyme, so that improves soil CBR value and roadway thickness is a feature of soil subgrade CBR value.

Conflict of Interest

The author declares that there is no conflict of interests regarding the publication of the manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy has been completely observed by the authors.

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