SOIL STABILIZATION BY USING TERRAZYME

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ABSTRACT
The most important aspect of any project is its cost, performance, durability and time. As the methods used conventionally were very uneconomical and time consuming, there is an urgent need for development of new techniques which enhances the geotechnical properties of soil. The Bio Enzyme has emerged as a material which drastically improves the properties of soil, is ecofriendly and is economical in long run. In the present study, the virgin soil (Dehradun) was mixed with various dosages of TerraZyme with different durations and had shown significant improvement in index properties of soil for e.g. Specific gravity, Optimum Moisture Content and Maximum Dry Density, and California Bearing Ratio (unsoaked and soaked). And on the bases of experimental results the optimum dosage of TerraZyme was find out. As the enzyme is an organic liquid, it is biodegradable in nature and it does not have any harmful effect on environment. Bio enzyme reduces the voids between the particles of soil and minimizes the amount of absorbed water in the soil so that compaction caused by enzymes can be maximum.

KEYWORDS: *soil stablization, terrazyme, specific gravity and california bearing ratio*

I. INTRODUCTION

The process of improving the strength and durability of soil is known as soil stabilization. The main aim of stabilization is cost reduction and to efficiently use the locally available material. Most common application of stabilization of soil is seen in construction of roads and airfields pavement. Chemical stabilization is done by adding chemical additives to the soil that physically combines with soil particles and alter the geotechnical properties of soil. Enzymes enhance the soil properties and provide higher soil compaction and strength. TerraZyme is non toxic, non corrosive and inflammable liquid which can be easily mixed with water at the optimum moisture content. TerraZyme improves the properties of soil and strength of soil significantly. Life of a structure increases as CBR value is increased and consistency limits are decreased. The chemical bonding of the soil particles is increased by the use of TerraZyme and a permanent structure is formed which is resistant to wear and tear, weathering and infiltration of water in soil. Apart from improving strength of soil this bio enzyme replaces the need of granular base and sub base. TerraZyme dosage entirely depends on the type of soil, clay content and plasticity index of soil. Different parameters were considered in the present work to check the effects of TerraZyme on local soil. This paper is organized as follows. In section 1.2 a brief introduction of TerraZyme is given .In section 2 the work done in past is reviewed . Finally, the experimental results and conclusion are presented in section 4 and 5 respectively. Future scope and references are mentioned in section 6 and 7.

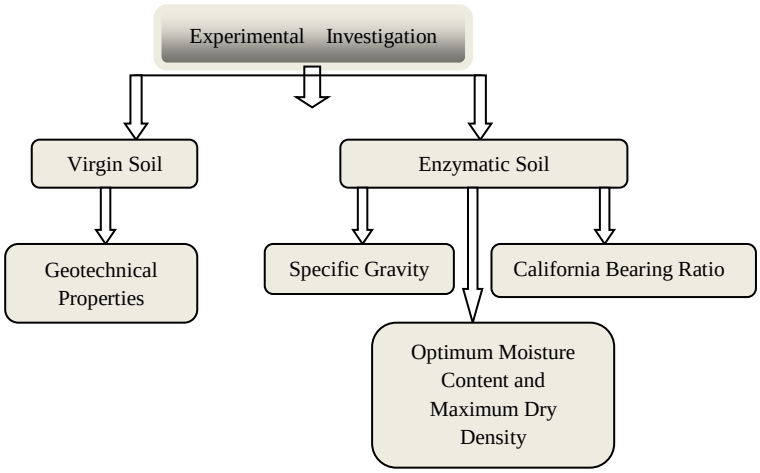

Figure 1. Experiments performed on soil

1.1 TERRAZYME

TerraZyme is a liquid enzyme which is organic in nature and is formulated from the vegetable and fruit extract. It improves the quality of soil like CBR, durability and decreases the OMC, plasticity index of soil. The effect of TerraZyme on soil is permanent and the soil becomes bio degradable in nature. The reason behind the improvement of soil properties is the cat ion- ion exchange capacity of the clay. Friction among the soil particles increases as the water is expelled out from the soil. Terrazyme forms a protective coating around the clay particles and thereby making clay particles water repellent. These organic enzymes come in liquid form and are perfectly soluble in water, brown in color and smells like molasses. Irritation in eyes may be caused by TerraZyme sometimes but the handling of this enzyme is easy i.e., masks and gloves are not required. Dosage of TerraZyme is of utmost importance, if less amount of TerraZyme is mixed with soil the effects will not be satisfying which means soil will achieve less stability and if TerraZyme is overdosed it will result in the higher cost and stabilization will become ineffective. In order to find out the optimum dose of TerraZyme in particular soil series of CBR test is performed on each sample with different amount of TerraZyme.

1.1.1 Mechanism of Stabilization

Terrazyme reacts with absorbed water layer of clay particle and causes reduction in the thickness around particle of soil, this result in the reduction of voids between the particles of soil, thereby giving soil particle a closer orientation with low compaction. This ultimately results in the decrease in swelling capacity of soil and it also reduces permeability of soil.

1.1.2 Benefits of TerraZyme

As the strength and stiffness of the soil is increased by adding TerraZyme to soil maintenance cost gets reduced by 30 to 50 %.It decreases the plastic characteristic of soil. Pavement thickness is reduced by 30 to 50%. Construction time is reduced by 50 %. TerraZyme improves load bearing capacity of soil.

1.1.3 Properties of TerraZyme

It is an organic liquid formulated from vegetable extracts. Temperature shall be maintained at 55 degree centigrade otherwise TerraZyme loses its properties. This organic liquid is stable in nature and the risk of decay is negligible. It is required to dilute TerraZyme with water before application. The aroma of TerraZyme has no harmful effect.

Table 1. Property of TerraZyme

Boiling Point	212
Specific Gravity	1.000 to 1.090
Melting Point	Liquid
Vapor Density	1
pH Value	4.30 to 4.60
Appearance	Brown clear liquid

II. LITERATURE REVIEW

Lacuoture and Gonzalez (1995) conducted study on the effects of TerraZyme on sub-base and sub-grade. The reaction of the soil treated with Bio Enzyme was observed and compared with soil without Bio Enzyme. It was concluded that soil showed improvement in short duration of time but the cohesive soils showed improvement successively. Bergmann (2000) concluded from his study on bio enzyme that for imparting strength to the soil, bio enzyme requires some clay content. He stated that for successful stabilization of soil minimum 2% clay content is required and 10 to 15 % of clay content gives good results. Compared to 28 % of untreated soil CBR after 1, 2, 3, 14 week was found as 37, 62, 66 and 100 respectively. Manoj Shukla et al. (2003) carried out test on five different type of soil. The clay content in soil varies from low to high. Tests were conducted on soil samples with and without Bio Enzymes to determine different engineering properties, Atterberg's limit, CBR and UCS at different curing period in laboratory. Little to high improvement is seen in the physical properties of soil with Bio Enzyme. The reason behind this little improvement is the chemical composition of soil which is less reactive with the Bio Enzyme. Sandy to silty type soil showed improvement in the CBR and UCS. It was observed that pavement thickness is reduced by 24 to 48 %. In places where the availability of granular material is less, Bio Enzyme treated soil with thin bituminous coating can satisfactorily fulfill the pavement requirement. Shankar et al. (2009) conducted tests on lateritic soil of Dakshina Kannad (district of India). The initial liquid limit and plastic limit of soil were 25 % and 6% respectively. The lateritic soil of the district was not satisfying the sub base requirement .For satisfying the sub base course requirements sand is mixed with soil in different proportions until specified values were attained.. Study was done on the effect of enzyme, on soil properties like CBR, UCS and permeability for a period of 4 weeks. CBR value increased by 300% with about 10 % sand and 200ml/m^3 of enzyme mixed with soil after 4 week of curing. An increase of 300% is seen the CBR value , increase of 450% in unconfined compressive strength value and decrease of 42 % in permeability of soil was seen with high dosage of enzyme of 200ml/2m^3 after 4 weeks of curing . It was concluded from the CBR results of treated and untreated soil that addition of enzyme in non-cohesive soil has no effect on the cohesion less soil. It was also stated that the bio enzyme used shall be checked for its effect on type of soil in laboratory prior to the field application. In order to check the efficiency of Bio Enzyme in field, test were performed on National Highway which affirms that soil blended with enzyme shows high CBR value than ordinary soil. Venkatasubramanian & Dhinakaran (2011) performed test on 3 different soils with different properties. These soils were tested with different dosage of enzyme. The liquid limit and plasticity index of soil were reported as 28, 30, 46 % and 6, 5 and 6 % respectively. An increase of 157 to 673 % is seen in CBR after 4 weeks of curing and 152 to 200 % in UCS.Vijay Rajorial, Suneet Kaur (2014**)** carried out a theoretical evaluation of enzyme. Reduction of about 18 to 26 % is seen in cost of construction of roads by using TerraZyme as a soil stabilizer, constructed by public work department in Maharashtra. Structures made of bio enzyme are economical and have greater strength.

III. RESULTS

The material which was used in the test is local soil (from Ballupur Road) and TerraZyme (bio enzyme). To find out the suitability of TerraZyme on soil laboratory test were performed. The TerraZyme was obtained by Avijeet agencies, Anna nagar Chennai, India. The dosage of TerraZyme is decided on the basis of type of soil. To study the variation of geotechnical properties of local soil we have taken 3m^3 per 200ml, 2.5 m^3 per 200ml, 2.0m^3 per 200ml and 1.5m^3 per 200ml. The prefatory tests were performed on the local soil with and without TerraZyme. The experimental analysis was carried out by taking dosage and curing time into consideration. The soil was crushed prior to tests and TerraZyme is mixed in different quantity for differ time period. Atterberg's limit test as per (IS: 2720, Part V-1985), Standard proctor test as per (IS: 2720, Part VII-1980), Grain size analysis (IS: 2720 Part IV -1985), Specific gravity analysis (IS: 2720, Part III -1980) ,California bearing ratio test (IS: 2720, Part XVI-1987) were performed on the soil in laboratory. According to 'Indian Standard Soil Classification System ', local soil was categorized as clay 'SM' type .Table 2. Shows the geotechnical properties of local soil.

3.1 Geotechnical properties of soil

Table 2. Geotechnical properties of soil

S.No.	Property	Value
1	Specific gravity	2.53
2	Grain size distribution	
	Gravel (%)	0.0
	Sand (%)	7.35
	Silt (%)	77.00
	Clay (%)	15.65
3	Consistency limits	
	Liquid Limit (%)	27.00
	Plastic Limit (%)	23.21
	Plasticity Index (%)	3.79
	Shrinkage Limit (%)	21.00
4	I.S .Soil Classification	Clayey silt (CM)
5	Engineering properties	
	Max. Dry Density, kN/m^3	17.90
	OMC (%)	17
6	C.B.R (%)	
	Unsoaked	5.60
	Soaked	2.36
7	Unconfined compressive strength kN/m^2	270

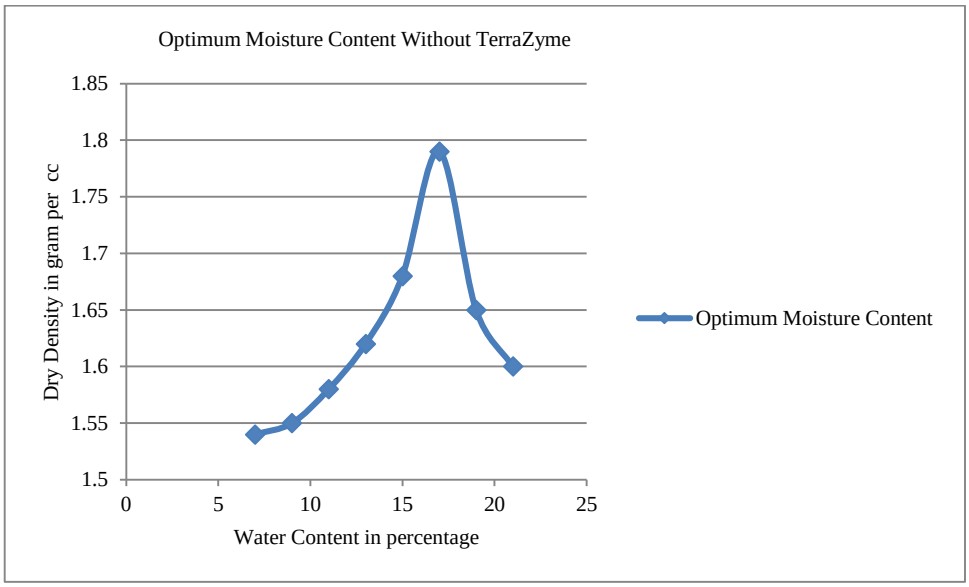

Figure 2. Optimum moisture content of soil without TerraZyme

3.2. Specific gravity

Specific gravity G is the ratio of unit weight of soil to unit weight of distilled water at 4 °centigrade. Specific gravity of soil is required for the calculation of unit weight, degree of saturation; water content etc .The unit weight is ultimately used for determining the settlement, pressure and stability problem. Table 3 shows the results of specific gravity of soil with TerraZyme in different dosage and for different time period. Initial specific gravity of soil sample was found to be 2.53.

Table 3. Specific Gravity test result

Dosages	Specific Gravity	
	Ist Week	II^{n} Week
3.0m^3/200ml	2.564	2.747
2.5m^3/200ml	2.59	2.87
2.0m^3/200ml	2.63	2.85
1.5m^3/200ml	2.54	2.72

3.3. Consistency limit test

Consistency limits are the boundary water content at which the soil undergoes from one state to another. Liquid limit test, plastic limit test and plasticity index falls under the category of consistency limit test. The initial liquid limit was 27%, plastic limit was 23.21% and plasticity index 3.79% without TerraZyme. Table 4 shows the result of consistency limits at different dosage of TerraZyme and for different duration.

Table 4. Consistency limit test result

Dosages	Consistency Limits	Ist Week	IInd Week
3m^3/200 ml	Liquid limit (%)	22.40	20.00
	Plastic limit (%)	17.00	15.50
	Plasticity index (%)	5.40	4.50
2.5m^3/200 ml	Liquid limit (%)	24.00	21.00
	Plastic limit (%)	17.50	16.00
	Plasticity index (%)	6.50	5.00
2m^3/200 ml	Liquid limit (%)	21.00	19.50
	Plastic limit (%)	17.00	16.00
	Plasticity index (%)	4.00	3.50
1.5m^3/200 ml	Liquid limit (%)	26.00	20.50
	Plastic limit (%)	17.10	16.30
	Plasticity index (%)	8.90	4.20

3.4 Standard proctor test

For determining the optimum moisture content and maximum dry density of the soil standard proctor test was conducted at laboratory .With the variable dosage of TerraZyme OMC and MDD were calculated for one and two week of curing. The OMC and MDD of soil without TerraZyme were found to be 17.9 % and 17kN/m^3. The effect of different dosage of TerraZyme after one and two week on OMC and MDD of soil is shown in table 5.

Table 5. Standard proctor test results

Dosages	OMC (%)		MDD (kN/m^3)	
	Ist Week	IInd Week	Ist Week	IInd Week
3.0m^3/200ml	10.00	10.00	1.79	1.80
2.5m^3/200ml	14.00	15.00	1.828	1.87
2.0m^3/200ml	10.00	14.00	1.823	1.88
1.5m^3/200ml	13.00	14.00	1.81	1.84

3.5California bearing ratio

California bearing ratio test was done for both unsoaked and soaked conditions. The test was performed by taking different dosages of TerraZyme i.e. ($3.0m^3$/200ml), ($2.5m^3$/200ml), ($2.0m^3$/200ml), ($1.5m^3$/200ml). Before performing test the sample of soil with different enzyme content are cured for one to two week. Table 6 shows the effect of TerraZyme on the CBR value of soil sample (Unsoaked). Figure 3 and 4 shows the 1 week and 2 week results of Unsoaked CBR respectively. While table 7 shows effect of Terrazyme on soil sample (soaked). Figure 5 and 6 shows the results of soaked CBR for 1 and 2 week respectively.

Table 6. Unsoaked CBR test results.

Dosages	I st Week	II nd Week
$3.0m^3$/200ml	17.22%	20.87%
$2.5m^3$/ml	15.16%	30.21%
$2.0m^3$/ml	16.84%	30.9%
$1.5m^3$/ml	14.20%	30.07%

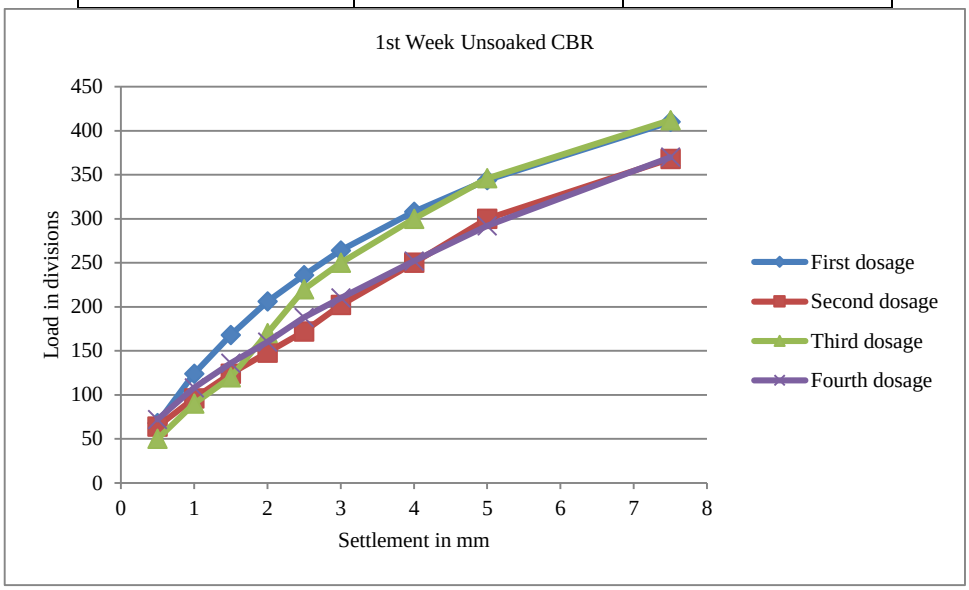

Figure 3. Unsoaked CBR Week 1

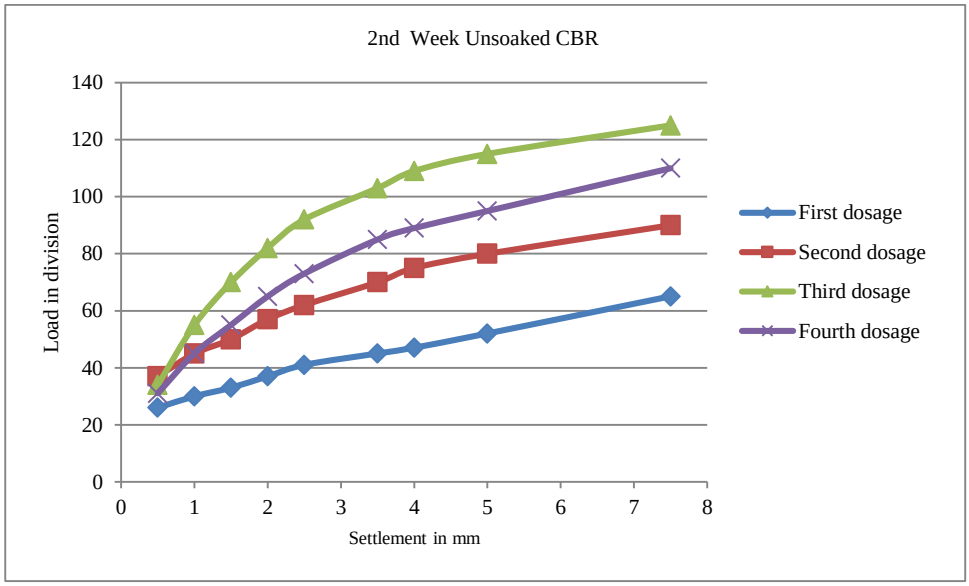

Figure 4. Unsoaked CBR Week 2.

Table 7 . Soaked CBR test results

Dosages	Ist Week	IInd Week
3.0m^3/ml	4.6	5.9
2.5m^3/ml	5.3	6.0
2.0m^3/ml	6.1	7.09
1.5m^3/ml	5.5	6.2

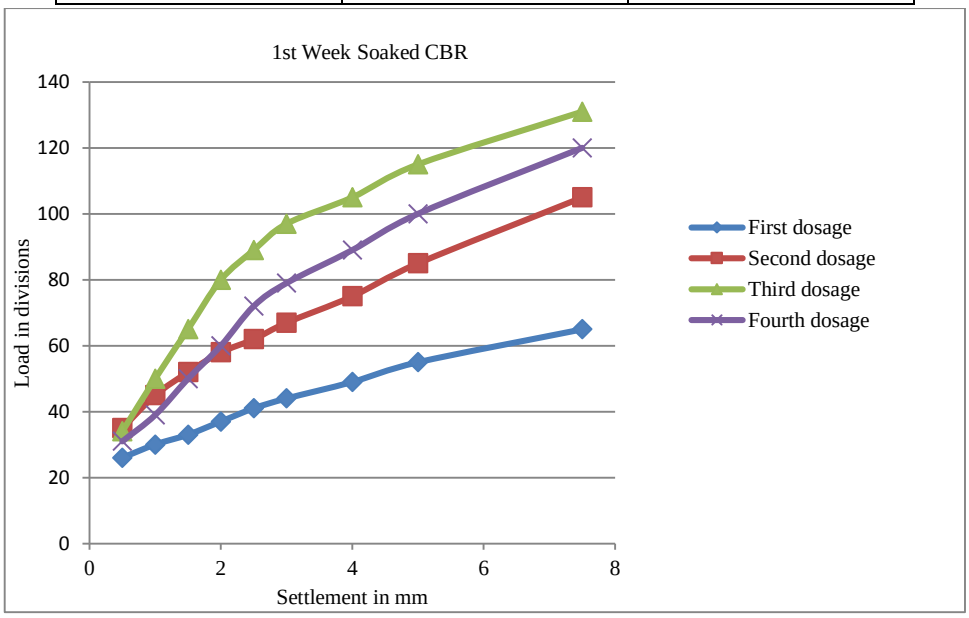

Figure 5. Soaked CBR Week 1.

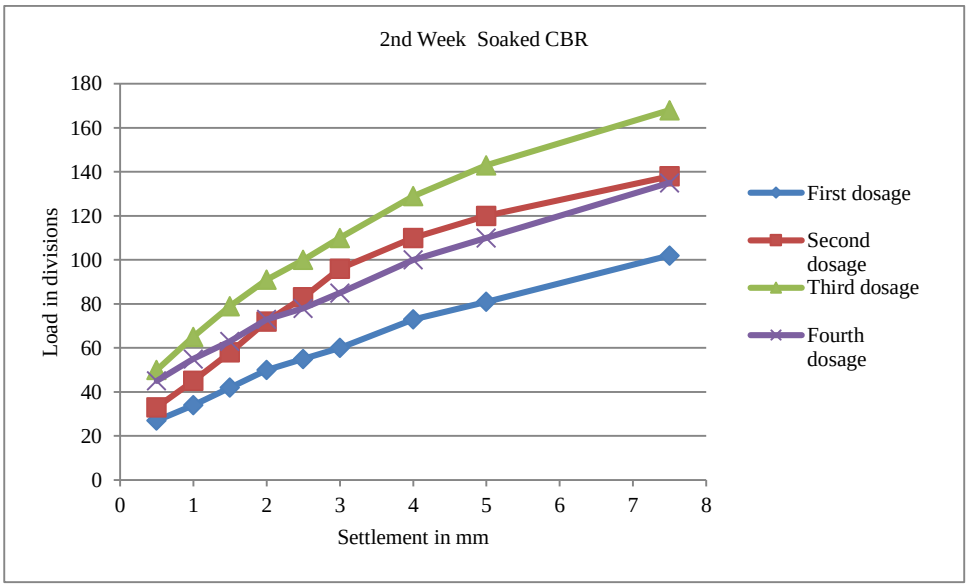

Figure 6. Soaked CBR Week 2

IV. CONCLUSION

- Bio Enzymes are non poisonous, organic and biodegradable in nature. The product formed after the application of TerraZyme is bio degradable in nature and the effect is permanent. TerraZyme eliminates the use of granular sub base and sub grade course.

- The MDD of local soil without TerraZyme was 1.79gm/cm^3 and OMC to be 17%.
- The initial cost of using TerraZyme is high as compared to traditional approaches but the benefit of using TerraZyme is that the maintenance cost is zero , making this approach economically cost effective.
- The third dosage of enzyme is the optimum one because the consistency limits are reduced and the soaked CBR increased after curing period of two weeks.

V. FUTURE SCOPE

- Other bio enzymes and their effect on soil can be studied.
- Further testes can be performed for permeability, direct shear test and dynamic behavior of soil to improve the soil property.
- Terrazyme effect on the soil with varying dosage and in varying stabilizing duration.

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