iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 **Issue:** VI **Month of publication:** June 2023

DOI: https://doi.org/10.22214/ijraset.2023.54410

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue VI Jun 2023- Available at www.ijraset.com

Application of Terrazyme (Bio-Enzyme) as a Soil Stabilizer

Swarnaprava Sahoo[1], SK Jaish Quadri[2], Bishwajit Kar[3], Chandan Mallik[4], Surajit Pattnaik[5]
[1, 2, 3, 4]B.Tech Student, [5]Prof, HOD Department of Civil Engineering (GIFT), Bhubaneswar

Abstract: Soil stabilization is a mechanical or chemical alteration of one or more soil properties to create an improved soil material possessing the desired engineering properties. 'e aim of this article was to review bio enzyme-based soil stabilization techniques with an emphasis onBio-enzymes production, mechanism of soil stabilization and future challenges, and opportunities of the sector. Soils are stabilized to increase strength and durability or to prevent erosion and dust generation. Cost-effective soil stabilization technology has been a fundamental part of any construction and is very important for economic growth in any country. In some cases, construction has been challenged due to the high cost of soil stabilization processes. Besides, methods of stabilizations using common stabilizing agents are getting costly. Currently, there is a growing interest to identify new and green technology to improve construction techniques and to expand the road network. Ere fore, the search for new materials and improved techniques to process the local materials has received an increased focus. For developing countries, bio enzymes are now creating an opportunity to improve soil stability with tremendous effectiveness in the overall process of soil stabilization. In the world, bioenzymes have been used in different projects for several years and are generally proprietary products, often of patented formulation that needs intensive field tests. Currently, the use and production of bio enzymes is becoming the most promising key for the advancement of a country by saving time, energy, and finance. It also reduces environmental pollution due to carbon emission by the conventional stabilizers. 'us, a better understanding of this emerging technology is of utmost importance to exploit any improvement it can offer to soil stability. With little research and practice, it is possible to produce soil stabilizing bio enzymes using local raw materials. Due to this, production of low cost, easily and widely applicable, and environmentally friendly enzymatic formulations from locally available raw materials should be the interest of research and academic institutes of any country. system is applied to several major cities across the globe to demonstrate its use and usefulness.

I. INTRODUCTION

A. General

Soil stabilization is the permanent physical and chemical alteration of soils to enhance their physical properties. In its broadest senses, it includes compaction, pre consolidation, drainage, and many such processes. However, the term stabilization is generally restricted to the process Which alters the soil material itself for improvement of its properties. It is the collective term for any physical, chemical, or biological method, or combination of such methods employed to improve certain properties of natural soil to make it serve for intended engineering purposes. Improvements include increasing the dry unit weight, bearing capabilities, volume changes, the performance of insitu subsoil, sands, and other waste materials in order to strengthen road surfaces, and other geotechnical applications. It is required when the soil available for construction is not suitable for the intended purpose and mainly aimed at increasing resistance to softening by water through bonding the soil particles together, water proofing the particles, or combination of the two.

Concept of stabilization is 5,000 years old and has been considered as old as construction has existed. Ancient Chinese, Romans, and Ices buildings and road ways which existed till today utilized different techniques of soil stabilization. Stabilized Earth roads were used in ancient Egypt and Mesopotamia and the Greeks and Romans used lime as a stabilizer. 'Us, building material dates back 5,000years when lime and clay were mixed and compacted to form bricks used in the construction of the pyramids and about2,000 years ago when the Romans used lime to improve thequality of their roads .

Modern stabilization techniques are aimed at assuring adequate subgrade stability, especially for weaker soils. Soil stabilization is generally costly and requires huge investments. In some cases, construction has been hindered due to the high cost of soil stabilization techniques and depletion of stabilizing materials. Development of cost-effective materials and processes has been a crucial part of any construction for years. Hence, cost-effective road construction techniques are vital for economic growth in any country.

As a result, there is an urgent need to identify new and cost-effective materials to improve construction techniques and expand road networks.

Recently, the search for new materials and improved techniques for processing the local materials has received an increased interest. In the past decades, a number of organic and inorganic chemical additives and different standard soil stabilizers like hydrated lime, Portland cement, and bitumen have been developed worldwide. However, more attention has recently been given to the use of bio enzymes as soil stabilizers

II. MATERIALS & METHOD OF EXPERMENTS

A. Soil

Locally available silty clay soil which was used for this project. This soil was collected from Mayurbhanj District.

The soil contains 83% particles finer than 75 micron. Fig 1 depicts the particle size distribution of this soil. The basic properties of soil or soil parameters obtained on conductingappropriate tests are as per IS: 2720 have been formulated in various parts. This part covers method of preparation of samples for the various laboratory tests covered in the standard.

The parameters of the soil obtained on conducting appropriate tests are given in the Table 3.1

B. Terrazyme-Bio Stabilizer

1) Enzyme stabilization is commonly demonstrated b termites and ants in Latin America, Africa and Asia. Ant Saliva full of enzymes is used to build soil structure which is rock hard and meters high. These structures are known to stand firm despite heavy tropical rain seasons.
2) Terrazyme is a nontoxic, natural, liquid enzyme that alters the physical and chemical features of soil. Soil enzymatic process improves the engineering qualities in the soil facilitating higher compaction densities and increasing the soil stability through closer bonding particles.
3) Terra-zyme is a liquid chemical used as a stabilizer in soil stabilization which can be easily mixed with water.
4) Terra-zyme increases the durability of soil pavement and reduces the swelling properties of soil.
5) The use of Terrazyme enhances weather resistance and improves load bearing capacity of soil
6) Enzyme stabilization is commonly demonstrated b termites and ants in Latin America, Africa and Asia. Ant Saliva full of enzymes is used to build soil structure which is rock hard and meters high. These structures are known to stand firm despite heavy tropical rain seasons.
7) Terrazyme is a nontoxic, natural, liquid enzyme that alters the physical and chemical features of soil. Soil enzymatic process improves the engineering qualities in the soil facilitating higher compaction densities and increasing the soil stability through closer bonding particles.
8) Terra-zyme is a liquid chemical used as a stabilizer in soil stabilization which can be easily mixed with water.
9) Terra-zyme increases the durability of soil pavement and reduces the swelling properties of soil.

C. Properties Of Terrazyme

1) Terrazyme is an organic liquid formulated from vegetable extracts.
2) Terrazyme is required 55degree centigrade temprature; otherwise it loose properties.
3) This organic liquid is stable in nature and the risk of decay is negligible.
4) It is required to dilute terra-zyme with water before application which has no harmfuleffect.
5) Terrazyme required long air-dry curing period with very little amount of solution.

D. Dossages Of Terra-Zyme

A dosage for expansive clayey soil was 200ml for bulk density of 1.98gm/cc.So, Bulk density of soil= 1.98 gm/cc

For Dosages 1: 200ml for 5.0m3 of soil = 1.98 × 5 ×1000 = 9900kg of soil.

For 3kg of soil = 3×0.022ml = 0.06ml enzyme.

E. Water

Clean potable water as obtained from laboratory of Civil Engineering Department of GIFT Autonomous College was used for mixing and curing of soil specimen.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue VI Jun 2023- Available at www.ijraset.com

Identity	Enzyme
Hazardous component	None
Boiling point	212^0F
Specific gravity	1-109
Melting point	Liquid
Evaporating rate	Same as water
Solubility in water	Complete
Appearance	Brown colour liquid

III. EXPERIMENT PROGRAMME

A. Preparation Of Soil Smple

Different mix of Soil + Terrazyme solution with geocell & original soil sample obtained to conduct specific gravity test, coarse and fine grained analysis of soil, Liquid and Plastic limit of soil , Modified Proctor test of soil ,UCS test on standard mould of sample size 38mm diameter and 76mm height , Tri-axial test of soil sample of size 75 mm(diameter) & 150mm (height). The curing period for the UCS soil sample are 7, 14, 21 &28 days respectably.

B. Mixing Procedure

Proper quantity mixing of Terrazyme solution with soil should be ensured to get correct test results of the soil specimen strength. For original soil sample initially the oven dried soil is weighed for required quantity and poured into another mixing tray or mould which is completely dry. For mixing with Terrazyme, the above-explained procedure is followed. Terrazyme which is mixed with water and according to OMC add the solution to the soil. Different terrazyme dosages 200 ml of ($4m^3$, $3.5m^{3,}$ $3m^3$ $2.5m^3$, 2m3, $1.5m^3$, & $1.0m^3$) ismixed and tested.

C. Curing Procedure

After preparing the soil sample, sample was kept air tight container for 7,14, 21 and 8 days. Maintain the moisture content properly.

D. Specific Gravity Of Soil

Specific gravity of soil particle (G) is the ratio of a unit volume of soil solids to the mass of the same volume of gas-free distilled water at a stated temperature (27^0C).

It is an important parameter and is also used for determination of void ratio and particle size. The standardized detailed procedure for the determination of the specific gravity of soil solids is contained in Indian standard specification.
Standard Reference:
IS 2720 (Part III) – 1980 is the standard recommended to determine specific gravity of fine grained soils.
The specific gravity of solid particle can be determined in the laboratory using many methodsthat is pycnometer method, density bottle method, jar method etc.
Pycnometer method used for corse graind soil whiledensity bottle method is used for fine granide soil.
Equation for specific gravity, G:
G= (W2-W1)/ ((W2-W1)-(W3-W4))
Where, W1= weight of empty bottleW2= weight of bottle + dry soil W3= weight of bottle + soil + waterW4= weight of bottle + water
Specific gravity for different soil is not same, generally the general range in which thespecific gravity of soil can be categorized as given in table:

IV. PARTICLE SIZE DISTRIBUTION

A. *Sieve Analysis Of Coarse Grained Soil*

The soil contains 83% particles finer than 75 micron. Rest 184 gram of oven dried soil are taken for Sieve analysis by the help of sieve shaker machine. The different sieve size are 4.75mm, 2.36mm, 1.18mm,0.600mm, 0.450mm, 0.212mm, 0.150mm, .075mm.

Standard Reference:

IS: 2720 (Part 4): 1985. Scope: To determine grain size of soil fraction passing through 4.75 mm IS sieve and retained on 75 micron IS Sieve.

B. *Grain Size Distribution Of Fine Grained Soil By Hydrometer Analysis*

Hydrometer method is used to determine the particle size distribution of fine-grained soils passing 75 µ sieves. The hydrometer measures the specific gravity of the soil suspension at the centre of its bulb. The specific gravity depends upon the mass of solids present, which in turn depends upon the particle size. Hydrometer analysis is an indirect method of assessing the size of soil particle bashed on stokes law which relates the velocity with which a sphericalparticle settles in a still liquid to the diameter of the particle. Hence the size of particle determined in this method is known as equivalent diameter. Hydrometer at any instant measures the relative density of soil suspension.The amount of soil taken 50 gms of oven dried which is passing through 0.075mm.

Standard Reference:

IS: 2720 (Part 4): 1985. IS: 2720 (Part 4): 1985. Scope: To determine grain size of soils.

V. LIQUID LIMIT TEST

The liquid limit is the moisture content at which a soil ceases to be plastic. After receiving the soil sample it is dried in air or in oven. The soil passing 425 micron sieve is used in this test. It becomes semi-fluid and tends to flow like a liquid under anapplied pressure. This limit is used for classification of soils for engineering purpose. The apparatus used for determining the liquid limit is liquid limit device *i.e.* Casagrande apparatus.

Standard Reference:

IS: 2720(Part 5)-1985-Methods of test for soils of determination of liquid and plastic limit.

Consistency of fine-grained soils may be defined as the relative ease with which a soilcan be remolded. Consistency limits may be categorized into three limits calledAtterberg limits. They are 1) Liquid limit 2) Plastic limit.

VI. PLASTIC LIMIT TEST

The plastic limit is the lowest moisture content at which a soil can be deformed without cracking. It is the upper limit of moisture content for tillage operation formost crops, except rice. Tillage operations in soil at moisture content above the plastic limit result in smearing and puddling of the soil.

Standard Reference**:**

IS: 2720(Part 5)-1985 - Methods of test for soils of determination of liquid and plasticlimit.

VII. SWELLING INDEX TEST

The swell index test procedure is used to determine the general swelling characteristics of betonies clay. The Swell Index test has not been demonstrated to have a proportional correlation to hydraulic properties, a high swell is considered by most to be a good indicator of betonies quality.Free Swell Index is the increase in volume of a soil, without any external constraints,on submergence in water.

Standard Reference:

IS 2720 (Part-40): 1977 "Method of test for soils Determination of Free swell Indexof soils".

REPORTING OF RESULTS

Free swell index

$= [V_d - V_k] / V_k \times 100\%$

Where, V_d = volume of soil specimen read from the graduated cylinder containingdistilled water.

V_k = volume of soil specimen read from the graduated cylinder containing kerosene.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue VI Jun 2023- Available at www.ijraset.com

Soil with kerosene   Soil with water

VIII. MODIFIED PROCTOR TEST

Soil compaction is the process of increasing bulk density and reducing pore volume asa result of the applied pressure. It leads to destruction of larger pores, re-arrangement of solid particles and compression of air within the pore spaces in the soil.

In this modified proctor test generally preferred as the road construction work and easily determine the O.M.C and M.D.D of soil.

Standard Reference:

IS: 2720 (PART 8): 1983, to determine the water content-dry density relation of soil using heavy compaction.

Modified proctor test (Heavy compaction)

Thermostatically Controlled Ovens

IX. UNCONFINED COMPRESSION TEST

The Unconfined Compression Test is a laboratory test used to derive the Unconfirmed Compressive Strength (UCS) of a soil specimen. Unconfirmed Compressive Strength (UCS) stands for the maximum axial compressive stress that a specimen can bear under zero confining stress.

Standard Reference:

IS 2720(Part 10): 1991, determination of unconfined compression test.

Preparation of soil sample

The mould size of the USC test is 38mm diameter and 76mm long. The amount or theweight of soil which is passing though the 425 µm sieve, required to prepare one soil sample.

$= Y_d \times$ vol. of mould

$= 1.685 \times \pi/4 \times d^2 \times h$

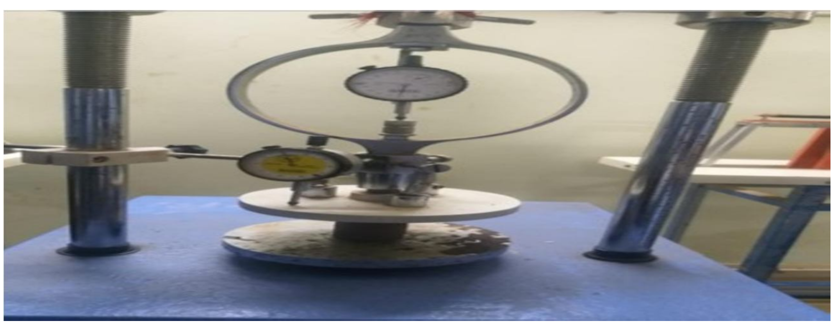
$= 1.685 \times \pi/4 \times 3.8^2 \times 7.6 = 146$ gram

The amount of water required to add the sol sample = Weight of soil sample × O.M.C
= 146 × 15.50 %
= 21.9 gm. or 21.9 ml

UCS Sample prepairation

UCS sample extractor

UCS SAMPLE FAILURE PATTERN



UCS Testing machine set up

X. RESULT AND DISSCUSION

This chapter deals with the presentation of test result, and discussion on shear strength, dry density and Triaxial test shear parameter development of original soil sample over reinforced soil and Terrazyme at different dosages 200 ML per (4, 3.5, 3, 2.5, 2, 1.5, ,1) and different curing period.

S.I No	Description	Trail-1	Trail-2	Trail-3
1	Wt. of dry Density bottle (W1)	33.33	33.33	33.33
2	wt. of dry Density bottle+ soil(W2)	43.30	43.20	43.00
3	Weight of dry soil taken W_d = (w2 - w1) g.	10.00	9.95	10.00
4	Weight of density bottle + soil + water (W3)	89.00	88.56	88.93
5	Weight of pycnometer + water (W4)	82.70	82.29	82.56
6	Specific gravity corresponding to test temprature(G_s)	2.70	2.70	2.75
7	Specific gravity corresponding to 27p c (G).	2.70	2.80	2.80
8	Average specific gravity	2.76		

Specific gravity of soil is-2.76

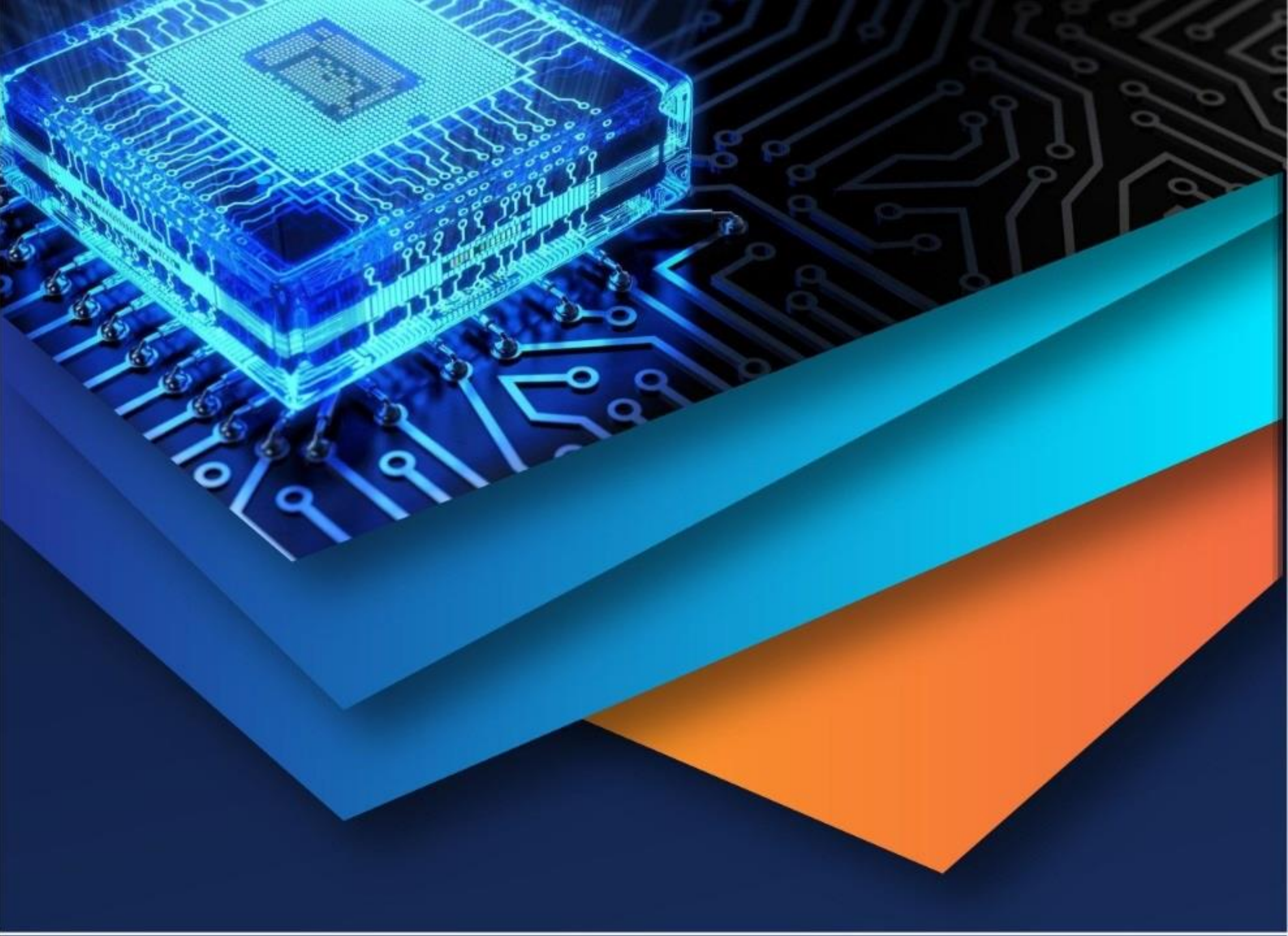
Sieve analysis:

The soil contains 83% particles finer than 75 micron. Rest 184 gram of oven dried soilare taken for Sieve analysis by the help of sieve shaker machine.

Result of sieve analysis

Sl.No.	Sieve size (mm)	Weight of soil retained (gm.)	% weight retained	Cumulative % retained	% Finer
1	4.75	0	0	0	100
2	2.36	0	0	0	100
3	1.18	0	0	0	100
4	0.6	33	17.93	17.93	82.07
5	0.45	38.7	21.03	38.97	61.03
6	0.21	49.2	26.74	65.71	34.29
7	0.15	22.6	12.28	77.99	22.01
8	0.075	40.5	22.01	100	0

Grain size distribution



10.22214/IJRASET

INDEX COPERNICUS
45.98

ISRA JIF
IMPACT FACTOR:
7.129

TOGETHER WE REACH THE GOAL
IMPACT FACTOR:
7.429

ISI

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY