

Soil improvement Using Biological Stabilization Treatment

Submitted by

SANTANU DAS

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In partial fulfillment for the award of the degree of

MASTERS OF TECHNOLOGY

IN

GEOTECHNICAL ENGINEERING



L LOVELY
P ROFESSIONAL
U NIVERSITY

Transforming Education Transforming India

Under the guidance of

MRS. CHETAN SANA KHAN

Assistant Professor

School of Civil Engineering

LOVELY PROFESSIONAL UNIVERSITY

Phagwara-144411, Punjab (India)

DECLARATION

I hereby declare that the dissertation report title “Soil improvement Using Biological Stabilization Treatment” is an authentic record of my own research work carried out as a requirement for the preparation of M.TECH dissertation for the award of Master of Technology Degree in the Geotechnical Engineering from Lovely Professional University, Phagwara, Punjab, under the guidance of Mrs Chetan Sana khan. All the information furnished in this report is based upon my intensive work and it's completely genuine to the best of my knowledge. And no part of the work in this report has been published before in any journal or presented for the award of any degree or honour.

DATE-

SANTANU DAS

11610764

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CERTIFICATE

Certified that this project report entitled “Soil improvement Using Biological Stabilization Treatment” submitted individually by student of School of Civil Engineering, Lovely Professional University, Phagwara, carried out the work under my supervision for the Award of Degree. This report has not been submitted to any other university or institution for the award of any degree.

Signature of Supervisor
Engineering

Head of Department Geotech

ACKNOWLEDGEMENT

I express my cavernous sense of obligation and gratitude to my guide ASSISTANT PROF. MRS CHETAN SANA KHAN, for her genuine and constant encouragement throughout this research work. I am highly obliged as my honourable guide for providing me such an opportunity to carry out research work under her continuous guidance.

I also wish to express my heartfelt appreciation to my friends, colleagues and many of who have rendered their support for the successful work towards the completion of the research work, both explicitly and implicitly.

NAME- SANTANU DAS

REG. NO- 11610764

Signature -

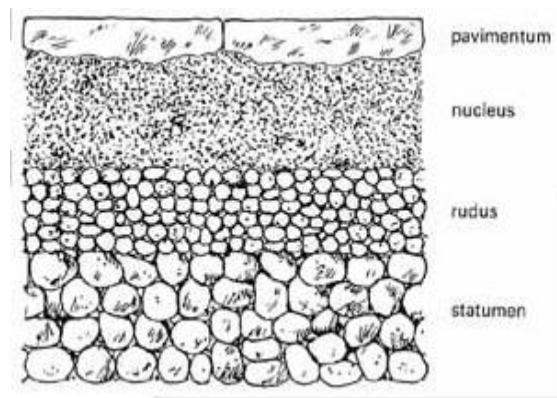
TABLE OF CONTENTS

CHAPTER DESCRIPTION	PAGE No.
DECLARATION	2
CERTIFICATE	3
ACKNOWLEDGEMENT	4
ABSTRACT	5
CONTENT	
LIST OF TABLES	20-22
CHAPTER 1 INTRODUCTION	6-13
1.1 General	
1.1.1 History behind Soil improvement	
1.1.2 Motive behind Development of soil	
1.1.3 Construction Incorporating by Soil improvement Using Biological Stabilization	
1.1.4 Benefits and Advantages	
1.1.5 Secondary Raw Materials	
1.1.6 Advantages of Using Secondary Raw Materials	
1.1.7 Role of Secondary Raw Materials in Strength Enhancement	
1.1.8 Use of Bacteria as improvement Material	
CHAPTER 2 LITERATURE REVIEW	13-17
CHAPTER 3 EXPERIMENTAL PROGRAMMES	18-20
CHAPTER 4 RESULTS AND DISCUSSION	21-25

INTRODUCTION

General- Soil change in its broadest sense is the adjustment of any property of a soil to enhance its designing perfection. This might be either a temporary procedure to allow the development of a facility or might be a lasting measure to enhance the discharged of the finished facility. The consequence of a utilization of a system might be more strength, less compressibility, decreased penetrability, or enhanced ground water condition.

History behind Soil improvement- The need of enhancing the building properties of soil has been perceived for whatever length of time that development has existed. Many outdated societies including the Chinese, Romans and Incas used different methods to enhance soil usefulness, some of which were effective to the point that a considerable lot of the structures and roadways they developed still exist today The present day time of soil adjustment started amid the 1960's and 70's when general deficiencies of totals and fuel assets constrained architects to consider contrasting options to the customary procedures of supplanting poor soils at building destinations with sent in totals that had more positive designing attributes. Soil adjustment at that point dropped out of support, for the most part because of broken application strategies and mistaken assumptions. All the more as of late, soil adjustment has by turned as worldwide interest for crude materials by famous pattern, expanded of fuel and frame work.



Construction Incorporating by Soil improvement Using Biological Stabilization Treatment-

Benefits and Advantages-

Cost feasible Solution- For any road or trait road, steady access having a fundamental to the business operation. Most soil strategies are permanent adjustment and needn't with application of study to maintain the conditions of road.

Less Time- Deferrals and mishaps can be very regular in significant hazard. With the use of a soil stabilizer, for example, EarthZyme, you can dispose of any pointless stoppages in work caused by precipitation or elements that are outside your ability to control.

Minimum Environmental Mark- Steady activity, particularly of mine locales where pull trucks convey with huge loads once a day, have negative effect on the earth. Stabilizer of soil can guarantee the road is not harmed amid and after undertaking.

Saves of Wastage- The soil stabilizers like as EarthZyme that are intended for use the soil on its location for the adjustment of road process. The EarthZyme that we use for clay content in soils to authorize the adjustment procedure. This need to pull the soils from off site for different materials.

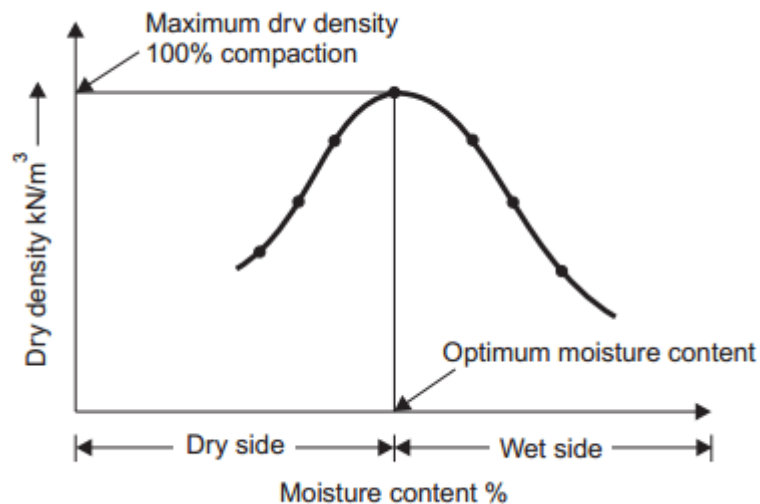
Effortlessly transported- EarthZyme thought of exceptions, empowering to bundled and dispatched. EarthZyme treat the compacted soil 33 m³/lit. It's makes the cost per km and mile of insignificant road opposite with elective items.

Ease of Application- EarthZyme easily connected for utilization standard develop the equipment and techniques. EarthZyme roads development requires a crushing blender, grader, water truck, and a steel drum roller or pulls truck. Preparing gives us environmental prides and specialized for helping point by point to our merchants about the effective risk.

Secondary Raw Materials- lime

Advantages of Using Secondary Raw Materials-

Water content-density relationship- lime is used for soil treatment. Particles of soil become large size bunch. Therefore the result of texture is changed. Process named Flocculation-agglomeration. That's why void ratio increases and dry density decreases also optimum moisture content increases.



Decreased plasticity index- Most plastic soils appear huge lessening in plasticity index. This decrease comes about because of the reduction in liquid limit of confinement and the expansion in plastic limit of binding.

Increase the frazzle strength- The material quantity of load cycles can be passing through at a steady stress level which reflects the tiredness quality of that material

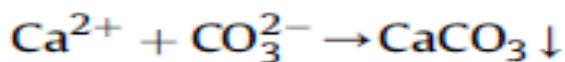
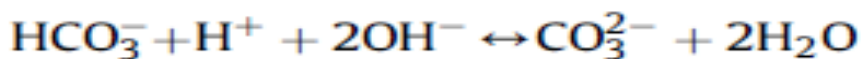
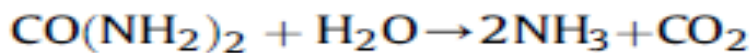
Increased durability- Lime-treated soil ability is known as durability. It opposes the adverse impacts of the wet-dry soil in which cycle of freeze-thaw coming out cause of the progress in ecological conditions into a year. Guarantee of the support-ability quality pick up performed by treatment of soil.

Increase in soil strength- A few scientists have utilized different strategies to assess the advancement of uncured and cured soil quality concerning lime content

Role of Secondary Raw Materials in Strength Enhancement- Lime mortars have been utilized for a considerable length of time in structural building development. Considering old landmarks and authentic structures it appears that these mortars have turned out to be strong and dependable materials in spite of the fact that they are of low quality in examination with cement mortars. Wet compressive strength increases by lime and Water absorption is fewer amounts.

Use of Bacteria as improvement Material- Sporosarcina Pasteurii, Bacillus

Chemical reactions of a series generated by urea hydrolysis Ammonia (NH₃) and carbon dioxide (CO₂) lead by chemical reaction .The hydroxyl ions (OH⁻) produced from the conversion of ammonia to ammonium, pH value result will be increase the decomposition of bicarbonate to carbonate ions lead by pH value, in the presence of water the carbon dioxide quickly decomposes into bicarbonate (HCO₃⁻) by water and it changed by hydroxyl ions to carbonate ions, for the precipitation Sporosarcina pasteurii by calcium carbonate



Review of Literature

- Murtala Umar, Khairul Anuar Kassim, Kenny Tiong Ping present that the idea of utilizing natural process in soil change which is known as bio-mediated soil change procedure has demonstrated more potential in geotechnical building applications as far as execution and ecological supportability. This paper shows an audit on the soil microorganisms in charge of this procedure, and components that influence their metabolic exercises and geometric similarity with the soil molecule sizes. Two components of bio mineralization, i.e. organically controlled and naturally actuated mineralization were additionally talked about. Natural and different variables that might be experienced in situ during microbial induced calcite precipitation (MICP) and their impacts on the process were recognized and exhibited. Enhancements in the building properties of soil, for example, quality/firmness and penetrability as assessed in a few examinations were investigated. Potential utilizations of the procedure in geotechnical designing and the difficulties of field utilization of the procedure were distinguished.
- S. Negi, MD Faizan, D. Pandey, R. Singh present that soil adjustment clarified as the change of the soil properties by concoction and physical means, with a specific goal to upgrade the designing character of the soil. The basic target of the soil coordination adjustment is increase the bearing capacity of the soil, its imperviousness procedure will be weathering and penetrability. The long trait execution for any development extends lean upon the basic soils soundness. Unsteady soils can make remarkable issues for bitumen and structures, Therefore strategies of soil adjustment are important to guarantee the great firmness of soil that it can effectively manage the rick of the superstructure particularly in the soil event which are profoundly dynamic, additionally it spares a considerable measure of time and a huge number of cash when contrasted with the strategy for removing and supplanting the insecure soil. This paper manages the entire investigation of the change of soil properties and its adjustment utilizing lime.
- Sakyō, Kyoto Japan; katsumi.takeshi present that Three issues on the reuse of materials in geotechnical applications in Japan are introduced in this paper. In the first place, current status of reuse of unearthed soils is introduced. Since characteristic defilement has been a worry these years, a few endeavours including exploratory reviews to assess the ecological appropriateness of these materials have been directed. Second, traceability

in ecological geo-technics has been turning into a vital thought. One joint venture, in which the exhumed soils produced from shield burrow uncovering are used as a dirt material for recovery, uses the electronic toll accumulation (ETC) framework to track the dirt materials. Third, use of catastrophe squanders created by the 2011 East Japan seismic tremor and tidal wave is required. Challenges incorporate the best possible treatment to separate soils from waste blend and to use this soil in geotechnical applications.

- Raymond A. Wuana¹ and Felix E. Okieimen present that Scattered writing is outfit to basically audit the conceivable sources, science, and potential biohazard. The accessible procedures the various substantial metals such as lead, chromium, arsenic, zinc, cadmium, copper, mercury and nickel generally found in polluted soils. The standards, points of interest and burdens of immobilization, soil washing and phytoremediation procedures which are as often as possible recorded among the best exhibited common advancements for tidying up overwhelming metal debased locales are introduced. Remediation of overwhelming metal sullied soils is important to lessen the related dangers, make the land accessible for rural creation; upgrade nourishment security and land residency will be scale down having issues emerging from changes in utilize design for the land.
- S.K Singh present that Human exercises may bring about the presentation of substantial metals into the subsoil and additionally subsurface aquifer frameworks, either because of carelessness or unintentionally. The nearness of substantial metals constitutes a potential risk to human wellbeing and biological systems. The potential wellsprings of overwhelming metals as a contaminant are from modern effluents and leachates from city and mining strong waste transfer locales. Understanding the major association is a pre-imperative to unravel the dirt tainting and substantial metals portability issues and for any proposed tidy up or remediation measures. The filtering section test is an exceptionally valuable and flexible device that can be utilized to concentrate the co-operations amongst soils and different contaminants. The relocation of substantial metals through compacted soil sections are observed in draining segment tests to concentrate the dirt connections with overwhelming metals. This paper introduces the consequences of clump tests and draining section tests directed to analyse the co-operations of overwhelming metals (Cd, Cu, Pb) with strong soil with low penetrability as it can be utilized as liner in the built landfill site or any control framework. The outcomes are analysed and it is found that cadmium has most minimal impediment or biggest portability while lead has least

versatility because of most astounding adsorption degree among every one of the metals considered.

- Ping Wang, Jiang-shan Li, Hua-fang Wang present that To concentrate the impact of EDTA washing remediation on building properties of overwhelming metals debased soil, bunch tests were led to gauge the pH, penetrability, restrict water substance, compressibility and shear quality of lead sullied soil washed by EDTA; checking electron magnifying lens (SEM) and X-beam diffraction (XRD) were led to clarify the instrument of the variety of designing properties affected by EDTA washing. Comes about demonstrated that pH and attachment diminished as the grouping of EDTA expanded; and as far as possible expanded from 21.8% to 23.0% and fluid breaking point expanded from 41.6% to 43.3% as convergence of EDTA expanded from 0 to 0.15mol/L. The inward grinding point and compressibility of soil were increased after EDTA washing. Infinitesimal tests comes about demonstrated that the mineral substance of montmorillonite (from 7.87% to 0.07%), illite and albite diminished and quartz expanded by 11.09% as EDTA focus expanded. The cincinal schistose particles were diminished in the dirt and the course of action directionality of soil was debilitated as the EDTA focus expanded.
- Y. KEERTHI, P. D. KANTHI, N. TEJASWI, K. SHYAM CHAMBERLIN, B. SATYANARAYANA present that Step by step expanding interest of bond results in serious gathering of oven tidy from concrete plants. The transfer of this fine clean turns into an ecological risk. With a specific end goal to beat this issue, the research is done by various parts of the world to discover the practical or effective methods for utilizing concrete furnace clean (CKD) different applications like soil adjustment, bond creation, asphalts, squander item adjustment, and horticulture and bond items, and so forth. Remembering the requirement for mass utilization of these strong squanders in India, it was thought convenient to test these materials and to create particulars to upgrade the utilization of these mechanical squanders in soil adjustment. Over the span of the review, this examination has possessed the capacity to build up the responses amongst soil and concrete. It has been set up that the synthetic mixes found in soil; quartz, feldspar, dolomite, calcite, montmorillonite, kaolinite and so on respond with the concoction constituents found in various distinguished compound stabilizers. The motivation behind utilizing CKD, and alternate added substances, is to enhance the surface, increment the quality and diminish the swell attributes of the different soils. This paper speaks to the

adjustment of clayey soil utilizing concrete oven squander. The dirt taken from Ravendrapadu in Andhra Pradesh containing diverse properties in different rates is blended with CKD in various extents and parameters like dry thickness and dampness substance are discovered. By analysing the qualities acquired perfect qualities are gotten at half relative blend of CKD in all out rate.

- Parampreet Kaur, Gurdeep Singh present that Outline of Pavement depends on the introduce that base indicated basic quality will be accomplished for each layer of material in the asphalt framework. Each layer of street must oppose shearing. It ought to stay away from extreme avoidances that cause weariness breaking inside the layer and overlying layers, and avert exorbitant changeless disfigurement of densification. The nature of a soil layer is elaborating the capacity of the layer for load circulation over a more prominent territory is by and large expanded so that a decrease in the required thickness of the dirt and surface layers might be allowed. The most widely recognized changes of various layers are completed through incorporate adjustment better soil degree, diminishment of versatility record or swelling potential, and increments in sturdiness and quality. For wet climate for adjustment may like be utilized for development operations to for a work stage. This review concentrates on the ensuing development parts of treating soils with lime.
- Tamadher Abood, Mohamed A. S. Mohamed present that The question of this paper is to examine the impact of including distinctive chloride mixes including (NaCl, CaCl₂, MgCl₂) on the designing properties of silty mud soil. Different measures of salts (2%, 4%, and 8%) were added to the dirt to concentrate the impact of salts on the compaction attributes, consistency limits and compressive quality. The principle discoveries of this review were that the expansion in the rate of each of the chloride mixes increment the most extreme dry thickness, diminish the ideal dampness content. As far as possible, plastic breaking point and pliancy record diminished with the expansion in salt substance. The unconfined compressive quality expanded as the salt substance expanded.
- Ashkan GHolipoor Norozi, Siavash Kouravand, Mohammad Boveiri suggest that Soil adjustment implies change of the dirt's properties to meet the predetermined building prerequisites. Techniques for the adjustment are compaction and utilization of admixtures. Lime, Cement was generally utilized as stabilizer for changing the properties of soils. From the current reviews it is watched that, squander materials, for example, fly-fieri debris, rice husk slag, Waste Stone Powder and Waste tire line are utilized for this

expected reason with or without lime or bond. Transfer of these waste a material is basic as these are creating perilous impacts on nature. With a similar goal writing survey was embraced on usage of waste materials for the adjustment of soils and same is displayed here.

- Asma Muhmed and DariuszWanatowski present that Utilization for enhancing the building lime adjustment methods that can be properties, especially the quality, of delicate muds. Lime on the quality and microstructure tends to research the impact of hydrated of lime treated soil. A specific goal for research centre tests to show such impact and progression of was directed. Kaolin soil blended with 5% hydrated lime done by Atterberg limits, compaction tests, unconfined compressive quality tests and filtering electron magnifying lens (SEM) were done on. The outcomes demonstrated that the expansion of lime brought about a lessening in the pliancy of kaolin and a change in compaction properties. Lime expansion for the unconfined compressive quality (UCS) of balanced out soil encountered an expansion. The quality created Two factors impacting for measuring that we are considering. Curing time and water content are the factors. Curing time added to an expansion in the UCS range from (183 to 390) kilopascal, that is twice of the quality of untreated kaolin. SEM examination demonstrated lime-soil response the nearness of the cementitious items in the kaolin earth come
- Z. Sharifah Zaliha, Kamarudin, A.M. Mustafa Bakri, M. Binhussain, M.S. Siti Salwa present that Hunting down the best soil stabilizers to defeat issues happen by the delicate soils is as yet being the fundamental concern, not exclusively to accomplish the required soil designing properties additionally by considering the cost and the impact to the earth. The goal of this paper was to survey the methods that had been accomplished for soil adjustment in view of trial studies. Examination on different materials had been done to assess their viability as soil stabilizer, which included the utilization of sodium hydroxide added substance, fly slag geo-polymeric folio, different fiery debris and cementitious binders. These materials were examined in this paper and their viability for balancing out delicate soils were seen from the acquired results, only in term of quality, based on unconfined compressive quality (UCS) test and California Bearing Ratio (CBR) test that had been directed. The quality of delicate soils was altogether expanded with the utilized of these materials and assumed they had the potential as successful soil stabilizers in field application.

- M.ADAMS JOE, A.MARIA RAJESH present that the venture manages adjustment of soil utilizing modern waste. Inadmissible parkway sub review soil obliges adjustment to enhance its properties. Modern waste sand is utilized as crude materials when the sand can never again be reused in the business, it is expelled from the business and is named as mechanical waste sand. Fixings utilized are Copper slag, bond and lime. Copper slag is a by result of Copper industry Lime was purchased from locally accessible substance research facilities. The venture are wanted to lead different examination like Specific gravity, strainer investigation, delegate compaction test, unconfined compressive quality and CBR test to build quality properties and conduct of sub base. At that point the outcomes and diagrams of different blends are contrasted with see their belongings in sub base adjustment. The adjustment method has an extra advantage of giving a domain benevolent approach to manage modern waste sand.
- Karthik, Ashok Kumar, Gowtham, Elango, Gokul present that Soil is an impossible to miss material. Fly Ash, rice husk powder is the waste materials use to make the soil to be steady. The physical and compound properties of the dirt Expand of such materials will build. CBR value should be enhanced to some anticipating that properties, shear quality, liquidity record, pliancy file, unconfined compressive quality and bearing limit and so on. Fly Ash gotten from burning The target of this review to assess the impact of sub-bituminous coal treated at electric power plants in delicate fine-grained red soils for adjustment of California bearing proportion (CBR) and other quality property tests were led on soil. The soil is in scope of flexibility and versatility lists extending in limits of 25 and 30. Tests were directed on soils and soil–Fly Ash blends arranged at ideal water substance of 9% .Addition of Fly Ash brought about apparent increments in the CBR of the soil. For water substance 9% wet of ideal, CBRs of the dirt’s are found in differing rate with the end goal that 3,5,6and 9.We will discovered ideal CBR estimation of the dirt is 6%.Increment of CBR esteem is utilized to decrease the thickness of the asphalt. What more, expanding the bearing limit of soil.
- Jijo James and P. Kasinatha Pandian present that This paper examined the capability of three strong squanders viz. Phosphogypsum (PG), Ceramic Dust (CD) and Red Mud (RM) in improving the uniaxial quality of an extensive soil. Locally accessible broad soil was gathered and described in the research centre and were balanced out utilizing the three strong squanders. Barrel shaped examples of 38mm x 76mm were thrown for assurance of the uniaxial quality and were cured for a time of 7 days. The consequences

of the quality tests uncovered that the expansion of strong squanders enhanced the quality of the far reaching soil. RM was observed to be the best of the three strong squanders in enhancing the quality of the dirt. Notwithstanding, the quality created couldn't meet the base prerequisites stipulated by code for sub base adjustment nor coordinate to the quality accomplished by lime or lime- pozzolan adjustment. It is presumed that valorisation of strong squanders is best accomplished by joining strong squanders with essential stabilizers like lime during the time spent soil adjustment.

- Sandeep Panchal, Md. Mohsin Khan, Anurag Sharma present review gives a compelling method of ground change utilizing bio-chemical. In this review a bio-compound named terrazyme is utilized for enhancing the California bearing proportion (CBR) esteem in street development. Terrazyme is a characteristic, non-dangerous and fluid protein. It is produced using maturation of plants, vegetable concentrate and organic product separate. Terrazyme can be utilized as soil stabilizer and furthermore it can enhance the CBR esteem in street development. The measurements of terrazyme are taken as 500ml/m³, 700ml/m³, 900ml/m³ and 1000ml/m³ in the dirt specimen and result is investigated. A critical increment is found in CBR estimation of the dirt example as the measurement of terrazyme has been expanded.

EXPERIMENTAL PROGRAMMES

Standard Procter Test- normal soil

Theory- When stress applied to soil it tends to densification as air is displaced between the soil grains from the pores in geo technical engineering. The standard Proctor compaction test is a laboratory method. It is regulating the optimal moisture content as given soil type and it will be maximum dry density condition when it will be most dense and gain.

NEED &SCOPE- The moisture content and density of soils determine the relationship the mould will be compacted with soil and 2.5 kg hammer drop from 30cm height. Bearing capacity of foundations will be increase; the undesirable settlement of structures will be decrease. Volume changes be controlled, hydraulic conductivity will be reduce, the stability of slopes will be increase.

APPARATUS REQUIRED- The capacity of mould 944 cc, inner diameter 10.2 cm, height is 11.6 cm. Detachable base plate and detachable collar assembly also needed for mould.

A hammer used which diameter and weight is respectively 5.08cm and 2.5 kg. And it will free fall from 30cm height of drop.

Sample extruder, mixing tools are mixing pan, spoon, towel, and spatula.

A balance of 15 kg capacity, Sensitive balance, Straight edge, Graduated cylinder, Moisture tins.

PROCEDURE:- oven-dried sample will be used, atleast 5 kg in the given pan. Water mix the sample water content of 4-10%.

Fix the collar and base plate, compact it in 3 layers giving 25 blows per layer with the 2.5 kg rammer falling.

Remove the sample from mould

Then added the water 60ml and continue the determination up to either a decrease or no change in the wet unit weight of the compacted soil.

Total weight of soil- 3kg

Weight of mould- 4.8 kg

1. Weight of mould + sample + 2% water- 7.05kg

2. Weight of mould + sample + 4% water- 7.12kg

3. Weight of mould + sample + 6% water- 7.21kg

4. Weight of mould + sample + 8% water- 7.38kg

5. Weight of mould + sample +10% water- 7.32kg

1. Cut of container- 43.32gm

Cut of container + sample- 54.14gm

Cut of container + sample after drying- 53.6gm

2. Cut of container- 33.51gm

Cut of container +sample- 44.08gm

Cut of container + sample after drying- 43.6gm

3. Cut of container- 42.25gm

Cut of container + sample- 48.72gm

Cut of container + sample after drying- 48.01gm

4. Cut of container- 49.47gm

Cut of container + sample- 57.77gm

Cut of container + sample after drying -56.77gm

5. Cut of container- 31.93gm

Cut of container + sample- 43.49gm

Cut of container + sample after drying- 42.33gm

No	Water content (W %)	Bulk density (γ)	Dry density (γ_d)
1	5.25%	22.5	21.37
2	7.68%	23.2	21.54
3	8.98%	24.1	22.11
4	10.13%	25.8	23.42
5	12.59%	25.2	22.38

Sieve analysis

Total weight of soil- 1 kg

Sieve size - (4.75>2.36>1.18>>600 μ >300 μ >150 μ >75 μ >Pan)

Sieve C ₁	Sieve size C ₂	Mass of each sieve C ₃	Sieve + retained soil C ₄	Mass of soil retained (C ₄ -C ₃)	Percentage of each C ₅ /W _n *100	Cumulative percentage of R _n	Percentage
1	4.75	.340	.502	.162	16.2	16.2	83.8
2	2.36	.324	.386	.062	6.2	22.4	77.6
4	1.18	.300	.412	.112	11.2	33.6	66.4
6	600	.296	.37	.074	7.4	41	59
7	300	.298	.317	.019	1.9	42.9	57.1
8	150	.290	.529	.239	23.9	66.8	33.2
9	75	.288	.301	.013	1.3	68.1	31.9
10	Pan	.416	.735	.319	31.9	100	0

Pycnometer test

Empty weight, $W_1 = .638\text{gm}$

Weight of pycnometer + soil, $W_2 = 1.112$

Weight of pycnometer + soil + water, $W_3 = 1.788$

Weight of pycnometer + soil + water, $W_4 = 1.486$

Specific gravity = $(W_2 - W_1) / (W_2 - W_1) - (W_3 - W_4)$

$= 1.112 - .638 / (1.112 - .638) - (1.788 - 1.488)$

$= .474 / .474 - .3$

Specific gravity = 2.72

Research Objectives

1. This research work will help to fulfil the infrastructural demand for the growing country like India.
2. With these research development activities has to be carried out on the weak and problematic soil due to the shortage of competent land space.
3. By using this research we can push forward the increasing awareness of environmental issues, there has been a remarkable shift toward “green” and sustainable technologies.

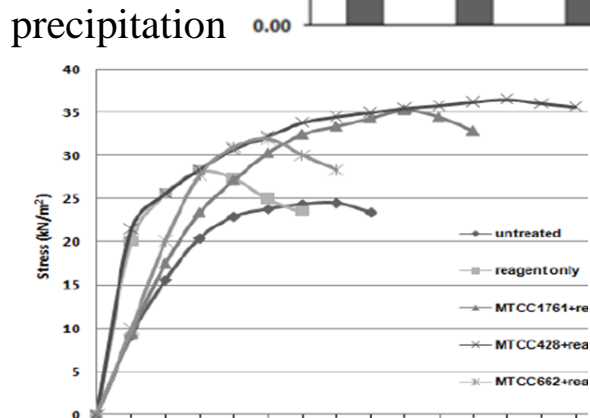
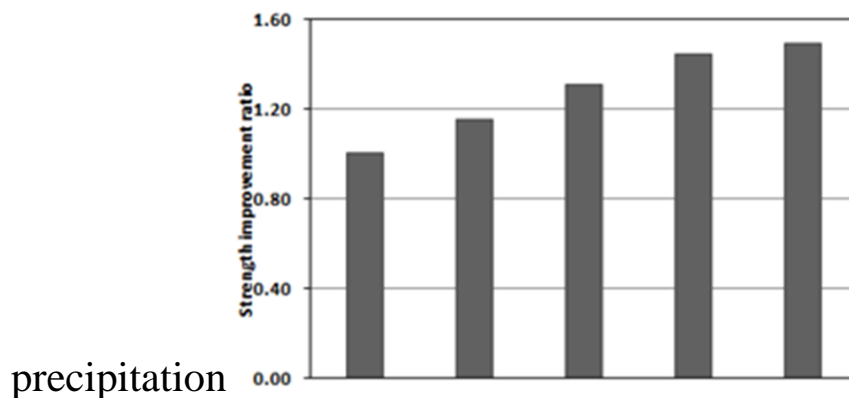
Research Gap

The process is homogeneous and long lasting. The technique is not harmful to the environment (eco- friendly) and less adopted. The treatment of soil offers economical ecological policy. The transportation cost will be fewer amounts.

Research methodology

In this technique, calcium carbonate precipitation has been induced inside the soil matrix by microorganism through their metabolic process to improve the engineering properties of soil. This technique is also called as microbial induced carbonate precipitation or MICP.

1. Collection of soil sample- normal ground (collected 5kg soil by digging 3m depth).
2. Engineering properties of soil sample-
MAXIMUM DRY DENSITY (MDD), OPTIMUM MOISTURE CONTENT (OMC), Liquid Limit (LL), Plastic Limit (PL), Grain Size, IS classification
3. Selection of Bacteria and batch cultivation- *Sporosarcina Pasteurii*, *Bacillus*
4. Quantitative analysis of calcite precipitation



Test Procedure

Sample collection- I shall be collects the sample by digging from 3 meter inside the soil surface (C- Φ soil)

Site name- Normal ground by digging 3cm depth at lovely professional university.

Landfill of open canal which is passing through from lovely professional university

Damping ground near at royal grand resort

I shall perform standard proctor test (SPT) to find out dry density and optimum moisture content at Chandigarh (CSIR).

Addition of *Sporosarcina Pasteurii*, *Bacillus Bacteria*.

After SPT test I will note down the SPT value the time interval of 5, 10, and 15,20,25,30 respectively up to 2 month.

Research Outcomes

1. Comparison of strength improvement ratio of different test specimens with respect to untreated specimen.
2. Strength value of specimen treated with lime only.

Reference

- Murtala Umar, Khairul Anuar Kassim, Kenny Tiong Ping Chiet University Technology Malaysia (April 2015)
- Z.S. Zaliha, Kamarudin, A.M. Mustafa Bakri, M. Binhussain, M.S. Siti Salwa (March-2010)
- Asma Muhmed and DariuszWanatowski (May-Jun 2013)
- M.ADAMS JOE, A.MARIA AJESH (7, July 2015)
- S. Neg, MD Faizan, D. Pandey, R. Singh (February 2013)
- Kyoto University, Sakyo, Kyoto Japan; katsumi.takeshi (2011)
- RaymondA.Wuana¹ and FelixE.Okieimen² (23 August 2011)