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A Review on Stabilization of Soil using Various Admixtures

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***Abstract*— A pavement is a hard crust constructed over a soil for the purpose of giving the stable and even surface for the vehicles, likewise buildings meant for habitation. But if the soil supporting the buildings and pavements is weak, it will leads to failure and the purpose will not be served. So the supporting soil needs to be stabilized. But the conventionally used methods are uneconomical. So, the need of developing the soil stability with low cost and environment friendly is necessary. In this paper, various articles have been reviewed in order to discuss the various economical and effective ground improvement techniques (GIT). In those articles the various stabilizing agents employed for soil stabilization are Bio Enzyme, terrazyme, permazyme, lime, fujibeton, renolith, lime, quarry dust, fiber, etc. The effect of these stabilizing agents and its optimum content for effective Ground Improvement process are also been discussed.**

Keywords: GIT, Bio Enzyme, terrazyme, permazyme, lime, fujibeton, renolith, lime, quarry dust, fiber.

INTRODUCTION

Many areas of India having clay and silt content (black cotton soil).These soils are normally expand when the moisture content is increased .so these soils are also called as expansive soils and swelling soils. These soils having the bearing capacity is low during the construction. So the engineers forced to find to increase the bearing capacity of soil by soil stabilization. Expansive soils are stabilized by many additives added with it.

Normally the expansive soils are stabilized with lime. It is an effective additive used in stabilization of expansive soils.

Nowadays the environment friendly soil stabilization methods are used in many developed countries. According to that the enzymes are used for soil stabilization. Enzymes are present in every plants and animals. It is used in the soil stabilization, which reacts with the soil minerals and stabilized it. Normally permazyme and terrazymes are used in this soil stabilization.

In developed countries like japan and Germany the renolith and fujibiton substances are used in soil stabilization. Renolith and fugibeton substances along with cement are used in stabilization of expansive soil. Renolith reduces the cost of stabilization by 20-30% and Fujibiton is a chemical polymer react with cement and used for stabilization of all soils. The effect of these additives in soil is described below. The different dosages of additives give different stability to the soils.

1. ENZYMES

Enzymes are non-toxic and non-flammable material which is fermented from plants and animals. In this review paper two enzymes are used for stabilization of expansive soil.

1.1 Terrazyme

Venkateshwaran and Dhinakaran have been studied that, Terrazyme is a natural liquid enzyme collected from various vegetable extracts. In this project three different dosage of terrazymes are used to improve the properties of soil. The terrazymes are added with three different dosages in expansive soil. The effect of terrazyme increase the stability of soil for different dosages is given in the table.

Dosage of Terrazyme	Liquid limit	Plastic limit	Plasticity index(PI)	OMC	MDD
0ml/m³	42.25	18.6	23.65	14.5	1.62
100 ml/m³	42	19	22	14	1.775
200 ml/m³	41.20	20	21	13.5	1.79
300 ml/m³	41	20.5	20.5	13.1	1.815

In this tests we can see,

The liquid limit of the stabilized soil is reduced upto 0.25% for every 100ml/m³.The plastic limit of the stabilized soil is increased from 0.5-1% for every 100ml/m³.So, the plasticity index of the stabilized soil is reduced to 1-1.5% for every 100ml/m³.So the swelling potential of the soil is reduced.

So, the soil is stabilized by using this terrazyme

1.2 Mechanism

Terrazyme react with soil particles and reduces the voids between Soils and it is easily gets closer when load is applied on the soil surface. Due to this effect, the permeability of the soil reduced and swelling of the soil is also reduced. The properties of the soil like consistency limit and OMC is decreased and the minimum dry density and CBR values are increased.

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2. PERMAZYME

UTAH (Road supervisor) have been studied that, the stabilization of soil is not done in laboratory. The permazymes are directly used in road pavement soil by Utah. He reduces the road maintenance to 25% for 8 years.

Permazyme is a natural enzymes is also fermented from vegetables and death animals.

2.1 Procedure

- Permazyme does not require any special machines or materials
- permazymes are easily applied on the road with water during compaction
- In this project 15 gallons of permazymes are used for 25-feet and 6-inches depth road
- Permazyme interact with a soil material and bonding process occurs .It increases the soil strength

2.2 Mechanism

The mechanism of permazyme in soil stabilization is to increase the stability of soil. when the force is applied to the soil, its bonding between the soil particles is increased. This bonding is extended up to the soil resist the forces. so, when high load applied the soil will collapse. So, the soil strength is to be increased. When permazymes are applied to the soil the soil voids are reduced and the strength of the soil is increased.

2.3 Advantages

- Due to the application of permazyme, the durable and water resistant mix. It can be used in any climatic conditions
- Since, the permazymes are mixed in site itself there is wastage problems

3. RENOLITH

Anoop singh, Prasanth garg have been studied that, Renolith is also an enzyme which is used in Germany. It is used in pavement soil with cement. It create the exothermic reaction and produce the dense layer in a stabilized soil.

First cement is added with a soil as 2%,4%,6% of soil weight and the renolith is added as 1,2,3,4% and the test is carried out.

3.1 Permeability Test

For 2% of cement added

Dosage of remolith to weight of cement	Permeability(k) cm/Sec
0%	8.11×10^{-5}
1%	1.44×10^{-5}
2%	5.05×10^{-6}
3%	2.01×10^{-6}
4%	9.51×10^{-7}
5%	6.80×10^{-7}

From this test the permeability of the soil is reduced due to the addition of renolith dosage. Because the porous of the soil is reduced and for 6%, 10% of cement the permeability of the soil is reduced 1-2% of 2%, 4% of cement used accordingly.

3.2 CBR Test

CBR value of the soil is increased 1-1.5% due to the addition of 1%, 2%, 3%, 4% of renolith for 2% of cement. And for 6%, 10% of cement the CBR value of the soil is increased 3%.

3.3 Standard Proctor Test

Percentage of cement taken	OMC (%)	OMC decreased in %	MDD (Kg/m^3)	MDD increased in %
0	17.00	---	1770.25	---
2	16.82	1.06	1810.35	2.27
4	16.50	2.94	1845.35	4.24
6	16.45	3.24	1870.27	5.65
8	16.07	5.47	1920.06	8.75
10	15.88	6.59	198e0.65	11.89

In this test, the optimum moisture content is reduced to1% and the maximum dry density is increased by 2-2.5% for every 2% increase of renolith.

3.4 Mechanism

Renolith is a chemical substance, it react with the soil particles. The soil is coated when renolith is added. It creates the soil-polymer matrix. The soil polymer matrix have high tensile and shear strength. So this soil can be used as a sub-grade in pavements.

4. FLYASH

Karthik. S, Ashokkumar. E, Gowtham P have been studied that, fly ash contents of 0, 5, 10, 15 and 20% on a dry weight basis to the expansive soil and it is found that the increase in fly ash content reduces plasticity characteristics and the Free Swell Index was reduced by about 50% by the addition of 20% fly ash.

4.2 Test Results

CBR Test and UCC Test

FLYASH %	CBR	UCC
0	3.1	3.881840
3	2.9	4.100000
5	3.12	4.440923
6	4.82	8.881850
9	3.03	4.885015

4.3 Proctor Test

FLY ASH %	% of OMC	% of MDD
0	8.9	2.11
3	9	2.07
5	8.2	2.31
6	10.2	2.35
9	9.3	2.21

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From this, we can found the fly ash does not affect the optimum moisture content and dry density of soil

5. LIME

Ankit singh negi, Mohamed, have been studied that, when lime and water are added to the soil, the pH value of the soil increases to above 10.5. So the clay particles are break down. Calcium in lime react with the silica and alumina in the soil and form calcium-silicate-hydrates (CSH) and calcium-aluminate-hydrates (CAH). It creates the matrix that improves the strength of the soil layers. And the matrix layer is impermeable and high load bearing capacity. The process is easiest one.

5.1 Advantages

The matrix-layer which is formed is

- Permanent
- Durable
- Impermeable
- Strong and
- Flexible.

5.2 Procedure

- Scarification of soil
- Lime spreading
- Preliminary mixing and watering
- Final mixing and pulverization
- Compaction
- Final curing

6 FUJIBETON

Fujibeton was initially originated in japan .It is a climatic resistant material due to that it is suitable for all type of soils. It is the type of inorganic polymer which chemically binds with all other compounds.

It is usually binds with the ordinary Portland cement which forms a certain mix which is known as fujibeton mix ,this helps to stabilization of soil in order to improves the engineering properties of soil.

This method is based on the concept of unconfined compressive strength of the soil, which results in the determination of different proportions of the soil-fujibeton mix.

6.1 Mechanism

In this method, there is a dispersing agent which increases the relative surface area of about 1000 times by gives a surface activating agent to cement particles due to the hydration process.

Although it takes longer time for initial setting to begin, it takes only shorter time for initial to final setting time, this is due to the action of CaCH3(CH2) 16COOH, which has the characteristic of rapid increases of viscosity and also have a uniformly hardening property after a definite period of time.

7. QUARRY DUST

ArunKumar U, Kiran B. Biradar have been studied that, A Large quantity of quarry dust particles and some other waste products are usually generated by crushing of gravel and rocks .The huge disposal of quarry dust and waste products cause serious impact on environment .Therefore, it is necessary to utilize the waste products in order to reduce the pollutants, so that it is used as a constructing material and also it reduces the total cost of construction

7.1 Properties of soil

Liquid limit(%)	47.70
Plastic limit(%)	25.65
Plasticity index	22.05
Percent finer	65.02
IS classification	CI
OMC(%)	15.80
MDD(kN/m³)	18.04
CBR Soaked	1.82

7.2Properties of quarry dust :

Specific gravity	2.68
OMC(%)	8.30
MDD(kN/m³)	17.02
Gravel Size	1
Sand Size	97
Fine Size	2

8 WASTE FIBER MATERIALS

Arpan Sen Rishabh Kashyap have been studied that, Fibers are used as a admixtures in soil stabilization. Fibers are applied to the soil by two methods. There are oriented fiber reinforcement and random fiber reinforcement.

8.1 Mechanism

Normally fibers have the tensile, shear strength. When it is added to the soil, the shear strength of the soil is increased. The fibers are laid by layer by layer on the subgrade soil pavements.

8.2 Direct Shear Test

Fiber reinforcement is added as a admixtures of 0.05%, 0.15% and 0.25%, and the cohesion is increased as 10%, 4.8% and 3.73% respectively. The angle of internal friction (φ) is increased to 0.8%, 0.31% and 0.47% respectively. Since the net increase in the values of c and φ were observed to be 19.6%, from 0.325 kg/cm² to 0.3887 kg/cm².

8.3 UCC Test

Fiber reinforcements of various percentage are 0.05%, 0.15% and 0.25% and the increase in unconfined compressive strength are 11.68%, 1.26% and 0.62% respectively.

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9. STABILIZATION OF BLACK COTTON SOIL USING BACILLUS-MEGATERIUM:

Bacillus megaterium is a aerobic spore forming bacteria which can be used for stabilization of soils.

In this study, the engineering properties and index properties will be increased by mixing this enzyme with soil. The water molecules that coat on the soil particles will be reduce thickness of the soil particles, so simultaneously the volume of the soil will also reduced.

It fast up the compaction process and stabilize the soil and it can used in sub-grade of pavement soil especially Black Cotton (BC soil) soil. This bacillus megaterium is low in cost

Atterberg's limit, Maximum Dry Density(MDD), Optimum Moisture Content(OMC),California Bearing Ratio(CBR),Unconfined compression test(UCC),Tri-axial compression test, Proctor compaction test are carried out to check the increased engineering properties of soil.

10. CONCLUSION:

1. By using bio-enzyme, aggregate free pavement is possible and also promotes the use of locally available material.

2. Use of bio-enzymes results in high compressive strength and also increases the hardness of stabilized soil.

3. Bio-enzymes provide flexibility and durability to the pavement and also reduce the formation of crack.

4. Bio-enzymes reduce the swelling and shrinkage properties of highly expansive clays.

5. Bio-enzyme can also be used as a dust control agent, as 75% of dust reduction in road surface is reported in many construction work where bio-enzyme have been used.

6. Increase dosage of enzymes increases maximum dry density and decreases optimum moisture content.

7. Bio-enzymes are the eco friendly substance, so that it will not contaminate to the ground water during rain water.

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