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MODERN SOIL STABILIZATION TECHNIQUES ADOPT IN THE CONSTRUCTION OF PAVEMENT

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Abstract

Searching for the best soil stabilization techniques to overcome problems occur by the soft soils are still being the main concern, not only to achieve the required soil engineering properties but also by considering the cost and the effect to the environment. The objective of this paper was to review the techniques that had been done for soil stabilization. There is another soil stabilization method called the Deep Mixing method that is non-destructive and effective at increasing California bearing capacity of weak or loose soil strata. Utilizing new soil stabilization technology, a process of cross-linking within the polymeric formulation can replace conventional road and house construction methods in an environmental friendly and effective way. This method is ideal for compaction weak soil strata, increasing and improving load bearing capacity under structures and the remediation of shallow and deep sinkhole problems. This is particular efficient when there is a need to support deficient public and private infrastructure.

Keywords: *stabilization, types of stabilization, methods, modern techniques.*

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1. INTRODUCTION

Soil stabilization is a method of improving soil characteristics by blending and mixing other materials. Or Soil stabilization a general term for any physical, chemical, biological, or combined method of changing a natural soil to meet an engineering purpose. Improvements include increasing the weight bearing capabilities and performance of in-situ subsoil's, sands, and other waste materials in order to strengthen road surfaces.

Originally, soil stabilization was done by utilizing the binding properties of clay soils, cement-based products such as soil cement, and/or utilizing the "rammed earth" technique (soil compaction) and lime.

Successful modern soil stabilization techniques are necessary to assure adequate sub grade stability, especially for weaker or wetter soils. It is widely recognized that the selection between the cementitious stabilizing agents cement and lime is based on the Plasticity Index (PI) of the primary soil type being improved. A PI of 10 is considered by many as the threshold that justices the cost for use of Portland cement compared with lime. Application rate of the selected stabilizing agent is important, both for durability and for cost considerations.

This paper will present an overview of some of the main features of modern soil stabilization technique.

1.1 Objective of Soil Stabilization

The prime objective of Soil Stabilization is to increase the California Bearing Ratio (CBR) of in-situ soils by 4 to 6 times. The other prime objective of soil stabilization is to improve on-site materials to create a solid and strong sub-base and base courses. In several regions of the world, typically developing countries and now more frequently in developed countries, soil stabilization is being adopted to construct the entire road.

Some measure objective of soil stabilization is as follows –

- Soil erosion control.
- Increasing the bonding between grains, increasing the mechanical strength & stability of soil.
- Reducing the volume of voids.
- Reducing the permeability.

1.2 Principal of Soil Stabilization

Soil stabilization means the improvement of stability or bearing capacity of the soil by the use of controlled compaction, proportioning and the addition of suitable admixture or stabilizers.

1. Evaluating the soil properties of the area under consideration.
2. Deciding the property of soil which needs to be altered to get the design value and choose the effective and economical method for stabilization.
3. Designing the stabilized soil mix sample and testing it in the lab for intended stability and durability values.

2. LITERATURE SURVEY

A. M. Mustafa (2013)

Searching for the best soil stabilizers to overcome problems occur by the weak soils are still being the main concern, not only to achieve the better required soil engineering properties but also by considering the cost and the effect to the environment. The objective of this paper was to re-evaluate the techniques that had been done for soil stabilization based on experimental studies. Investigation on various materials had been done in order to evaluate their effectiveness as soil stabilizer, which involved the use of sodium hydroxide additive, fly ash geopolymeric binder, various ashes and cementitious binders. These materials were discussed in this paper and their effectiveness for stabilizing soft soils were observed from the obtained results, only in term of strength, based on unconfined compressive strength test and California bearing ratio test that had been conducted. The strength of soft soils was considerably increased with the used of these materials and supposed they had the potential as effective soil stabilizers in field application.

2.1 Modern Techniques of Soil Stabilization

1. Fly Ash :

Fly ash is a pozzolanic material that consists mainly of silicon and aluminum compounds that, when mixed with lime and water, forms a hardened cementitious mass capable of obtaining high compressive strengths. Fly ash is a by-waste of coal fired, electric power-generation facilities. The liming quality of fly ash is highly dependent on the type of coal used in power generation. Fly ash is categorized into two broad classes by its calcium oxide (CaO) content. They are—

1. Class C.
2. Class F.

Class C: This class of fly ash has a high calcium oxide content (12 percent or more) and originates from sub bituminous and lignite coal. Fly ash from lignite has the highest calcium oxide content, often exceeding 30 percent. This type can be used as a stand-alone stabilizing agent. The strength characteristics of Class C fly ash having a calcium oxide less than 25 percentage can be improved by adding lime. Further discussion of fly ash properties and a listing of geographic locations where fly ash is likely to be found are in Appendix B. Class F. This class of fly ash has a low calcium oxide content (less than 10 percent) and originates from anthracite and bituminous coal.

Class F: fly ash has insufficient calcium oxide content for the pozzolanic reaction to occur. It is not more effective as a stabilizing agent by itself; still, when mixed with either lime or lime and cement, the fly ash mixture becomes an effective stabilizing agent. Lime Fly Ash Mixtures. LF mixtures can contain either Class C or Class F fly ash. The LF design process that requires laboratory analysis to determine the optimum fines content and lime-to-fly-ash ratio.

2. Cementation Stabilization

Cementation consists of injecting cement suspension into the soil to be stabilized through a system of boreholes drilled in the soil. The suspension has a mass ratio of cement to water in the range of 0.1-2.0 to increase the mobility of dense cement solution and cement sand solution sulphite alcohol vinasse can be added in the amount of 0-0.25%of the quantity of cement. Addition of calcium chloride in the amount of 1 to 5% of the quantity of cement can be used to regulate the acceleration of setting of the solution and increasing and initial strength of cement. The stability of soil and its water tightness increasing significantly after Cementation young hot Batman edition as well as Cementation is used cavernous Rocky Strata where surface flow attains a high speed. Method is used for very narrow fissures in rocky soil and for stabilization of sandy soil.

The soil stabilized with cement is known as soil cement. The cementing action is supposed to be the result of chemical reactions of cement with siliceous soil during the hydration reaction. The important factors affecting the soil-cement are nature of soil content, conditions of mixing, compaction, curing and admixtures used.

as follows:

1. Gravels – 5 to 10%
2. Sands – 7 to 12%
3. Silts – 12 to 15%, and
4. Clays – 12 – 20%

The amount of cement for a compressive strength of 25 to 30 kg/cm^2 should normally be enough for tropical climate for soil stabilization.

If the layer of soil having surface area of A (m^2), thickness H (cm) and dry density r_d (tones/m^3), has to be stabilized with p percentage of cement by weight on the basis of dry soil, cement mixture will be

$$\frac{100 \times p}{100 + p}$$

And, the quantity of cement required for soil stabilization is given by

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quantity of cement required, in tones

$$= \left(\frac{AHr_d}{100}\right) \times \left(\frac{p}{100+p}\right)$$

Lime, calcium chloride, sodium carbonate, sodium sulphate and fly ash are some of the additives commonly used with cement for cement stabilization of soil.

Fig cementation stabilization

3. Lime Soil Stabilization

According to the National Lime Association. Lime can be used to treat soils in order to get better their workability and load-bearing capacity in a various types of situations. Quicklime is frequently used to dry wet soils at construction sites and elsewhere, reducing downtime and providing an improved working surface. An even more significant use of lime is in the alteration and stabilization of soil under road and similar construction projects. Use of lime can substantially increase the stability, impermeability, and load-bearing capacity of the sub grade.

The use of lime to dry, modify or stabilize soils has been recognized in studies as much as fifty years old. Many state agencies developed specifications or procedures for lime stabilization of fine-grained and/or mixed soils when the United States interstate highway system was being constructed in the 1960s.

In 1999, the National Lime Association commissioned Dr. Dallas Little to evaluate, the structural properties of lime and to develop practical lime stabilization MDTP (Mixture Design and Testing Procedure). His work outlined that seven steps may be necessary for mixture design and testing of lime stabilized soils. The seven tests are identified by Dr. Little are as follows:

1. Initial soil evaluation

2. Determination of approximate lime demand

3. Determination of OMC (Optimum Moisture Content) and MDD (Maximum Dry Density) of lime-treated soil fabrication of UCS (Unconfined Compressive Strength) specimens

4. Curing and conditioning of ICS specimens

5. Determination of UCS of cured and moisture-conditioned specimens

6. Determination of change in expansion characteristics of specimens (only done for Expansive soils)

4. Chemical Stabilization

Chemical solution or another of the major type of soil stabilization. All of these techniques really on adding an additional material to the soil that will physically interact and change its properties. These are number of different types of soil stabilization on chemical additives of One Sort or another; you will frequently encounter compounds that utilize cement, lime, fly ash, chloride, Sodium Hydroxide or Kiln dust. Most of the reactions Sought are either cementitious or pozzolanic in nature depending on the nature of soil present at the particle particular site you are investigating.

The selection of type and determination of the percentage of additives to be used is dependent classification and the degree of improvement in soil quality desired. Generally, smaller amount of additives are required simply desired to modify soil properties such as gradation, workability and plasticity.

Calcium chloride being hygroscopic and deliquescent is may be used as a water retentive stabilizer in mechanically stabilized soil bases, sub bases and surfacing. The vapour pressure gets lowered, surface tension increases and rate of evaporation decreases. The freezing point of pure water gets lowered and it results in avoidance or decrease of frost heave.

The depressing the electric double layer, the salt reduces the water pick up and thus the loss of strength of fine grained soils. Calcium chloride acts as a soil flocculent and facilitates compaction. Frequent application of calcium chloride may be necessary to make up for the loss of chemical by leakage action. For the salt to be effective, the relative humidity of the atmosphere should be above 30%.

Sodium chloride is another chemical that can be used for this purpose with a stabilizing action alike to that of calcium chloride.

Sodium silicate is yet another chemical used for this purpose in combination with other chemicals such as calcium chloride, polymers, chrome lignin, alkyl chlorosilanes, siliconites, amines and quarternary ammonium salts, sodium hexametaphosphate, phosphoric acid mixed with a wetting agent.

5. Plastic as a Soil Stabilizer

Soil stabilization is any process that so improved the soil such as increase shear strength, resilience, can be made suitable material of cement, lime and fly ash as controlled waste, etc. The use of additives cost for the introduction of these additives has increased in recent years opened the door wide for the soil additives, such as plastic, bamboo, etc. Effectively used for this new technique soil stabilization to meet the challenges of society, to the waste, not to reduce the production of valuable material from waste makes sense. The use of plastic products such as plastic bags, bottles, etc is increasing waste day by day leads to several environmental problems. Request without environmental hazards real challenge. Therefore the use of plastic bottles is soil stabilizer is a useful says there is no shortage of good quality soil for embankments. We involve in the detailed study of the possible use of plastic bottles waste for improvement of soil stabilization. The analysis has been filled by testing the cargo floor panels with use of plastic with send and halve bottle in the middle and a third tank arranged reinforced executed. Comparing the test results showed that the court centrally positioned bottle where most effective in increasing the strength of soil. The optimum proportion of those what time was found by CBR test and the use of this percentage of plastic plate load test were also performed. The size and content of the torn waste plastic bottles have a major impact on the improvement of the soil strength.

6. Soil Stabilization with Rice Husk Ash and Fly Ash

Fly ash and rice husk Ash has been used: successfully in many projects to improve the strength characteristics of soils. Fly ash can be used stabilize bases or sub grades, to stabilize backfill reduce lateral Earth pressure and to stabilize embankments to improve slope stability. Typical stabilized soil depth is 15 to 46 centimetres (6 to 18 inches). The primary reason fly ash is used in soil stabilization applications is to improve the compressive and shearing strength of soil. The compressive strength of fly ash treated soil is dependent on:

1. In place soil properties
2. Delay time
3. Moisture content at time of compaction
4. Fly ash addition ratio

Advantages of Soil Stabilization

1. The contaminant can be stabilized in a relatively short time period stabilization can be used to treat persistent contaminants (e.g. Heavy metals, pcbs, dioxins)
2. Can be performed both in-situ or ex-situ
3. Process equipment can occupy a relatively small footprint
4. the structural properties of the soil may be improved by treatment (e.g. Strength, permeability)
5. The stabilized soil can be reused for construction applications or disposed of in a landfill for inert wastes.
6. Much greater cost certainty than the most other remediation options

Disadvantages of Soil Stabilization

1. Does not destroy or remove the contaminants
2. Can be difficult to predict long-term behavior
3. May require long-term maintenance of protection systems and/or long-term monitoring.
4. Potentially significant final volume increase

3. CONCLUSION

While constructing highways different ground conditions are encountered. Considering all factors a proper ground improvement technique has to be done. Ground improvement techniques have been widely used by developed countries. Lime stabilization is suitable for expansive soil like black cotton soils. In bitumen stabilization optimum content of bitumen vanes from 4 to 6 % soil. Chemical stabilization is costly compared to others. Stabilization by grouting is suitable only for soils with high permeability. Stabilization by Terrazyme is most effective fog; fine grained soil.

The use of modern soil stabilization techniques has significantly helped in ground improvement. This new technique of soil stabilization can be effectively used to meet the challenges of society, producing useful waste materials.

It can significantly enhance the properties of soil used in the construction of road and infrastructures. Results include a better and longer lasting road and structures with increased loading capacity.

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