Strengthening weak soils by soil stabilization techniques: A review article

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ABSTRACT
All soils on the earth are not homogeneous and vary with physical, chemical and bearing strength properties. Different types of soils possess variations in their engineering properties. Due to the increase in urbanization and as well as population on earth, it became necessary to provide new constructions for well living of human beings. But land available for the construction of more Civil Engineering structures is not enough and may not suitable. To overcome such problems with soils of diversity in their various engineering properties like bearing capacity, shear strength, shrinkage and swelling index, etc., a great diversity of ground improvement techniques such as soil stabilization are evolved to improve mechanical behavior of soil, thereby enhancing the reliability of construction. Now, I am discussing about some important soil stabilization techniques. These techniques improve the soil's shear strength and bearing capacity. The selection of correct method of soil stabilization for foundation soils became an important issue in the present engineering works.

Keywords *– Admixture, chemical stabilization, compaction, mechanical stabilization, soil stabilization, strength of soil.*

I. INTRODUCTION

Whatever the structure to be constructed, it necessary to consider the three criteria, in the point of view of a soil engineer:

- Pressure producing in the soil by its own weight and its function
- Particular kind of foundation to be provided
- Bearing strength of the sub soil at the location

From this, it became important that, the soil should have enough strength and bearing capacity for being stable and not under going to settlement and failure of the structure. In case of weak soils, the bearing capacity of the soil must be increased according the type of the structure be constructed.

The process of improving the engineering properties of soil to make it more stable is called soil stabilization. Such a process is required when the available soil exhibits undesirable engineering properties and not suitable for construction. The term stabilization is generally restricted to the processes which alter the soil material itself for improvement of its properties.

The stabilization of soil improves shear strength and bearing capacity of soil. The stabilization of soil reduces the permeability and compressibility of soil mass. And anyhow, stabilization of soil can be accomplished through operations like compaction, pre-consolidation, drainage and many other such processes.

II. METHODS OF SOIL STABILIZATION

In practical, various methods are available for soil stabilization. Here I am discussing about some important methods of soil stabilization and their effects on engineering properties of the soils.

2.1 Mechanical stabilization:
Mechanical stabilization is the process of improving properties of the soil by changing its gradation. Two or more types of natural soils are mixed to obtain a composite material which is superior to any of its components. To achieve the desired grading, sometimes the soil with coarse particles is added or the soils with fine particles are removed.

Mechanical stabilization is also known as granular stabilization. Aggregates of size larger than 75microns and binders of particle size less than 75microns. This stabilization depends on following factors.

- Mechanical strength of aggregates
- Mineral composition
- Gradation
- Plasticity characteristics
- Compaction

2.2 Cement stabilization:
Cement stabilization is done by mixing pulverized soil and Portland cement with water and compacting the mix to attain a strong material. The material obtained by

mixing soil and cement is known as soil-cement. The soil-cement becomes a hard and durable structural material as the cement hydrants and develops strength. For that Mitchel and Freitag (1959) divide that different types of soil-cement to used like normal soil-cement (5-14% of cement)for hard and durable construction material, other one is plastic soil-cement(5-14% of cement),but it has more quantity of water to have plastering mortar at the time of placement and moreover it for water-proofing lining of canals and reservoirs and against erosive action of water. Another one cement modified soil (lessthan5% of cement)it for reduce the swelling characteristics of the soil.

This cement stabilization in soil depends on following factors

- Type of soil
- Quantity of cement
- Quantity of water
- Mixing, placing, compaction and curing
- Admixture

This stabilization is done by the mix-in-place method and plant-mix method.

2.3 Lime stabilization:

Lime stabilization is done by adding lime to a soil. It is useful for stabilization of clayey soils. When lime reacts with soil, there is exchange of cations in the adsorbed water layer and a decrease in plasticity of the soil occurs. Generally, the hydrated lime (slaked lime) is used for the higher magnesium content of the lime, the less is the affinity for water and the less is the heat generated during mixing. The amount of lime required for stabilization varies between 2-10% of the soil.

The lime stabilization strength is depending up on the following factors

- Type of soil
- Amount of lime
- Ratio of fly ash and lime varies between 3-5%

2.4 Bituminous stabilization:

Bituminous stabilization is generally done with asphalt as binder. As asphalts are normally too viscous to be directly, these are used as cut-back with some solvents, such as gasoline. These are also used as emulsions, but in this form, they require a longer drying period.

The amount of bitumen require generally varies between 4-7% by weight. According to the Highway research board of USA, we classified by type of soil (soil-bitumen of 4-7%), sand-bitumen (4-10%), water proof-clay concrete(1-3%),oiled earth(5litres per square meter)

Bitumen stabilization can depend on following factors

- Type of soil
- Amount of asphalt
- Mixing
- Compaction

2.5 Chemical stabilization:

In chemical stabilization, soils are stabilized by adding different chemicals. The main advantage of chemical stabilization is that setting time and curing time can be controlled. Chemical stabilization is however generally more expensive than other types of stabilization.

The following chemicals have been successfully used

- Calcium chloride(1/2% of the weight of soil)
- Sodium chloride(1% of the weight of soil)
- Sodium silicate (0.1 -0.2%)
- Polymers(natural and synthetic resins)
- Chrome lignin(5-20% by weight)
- Other chemicals(alkyl chlorosilanes, silconatesamines, sodium hexa meta phosphate)

2.6 Thermal stabilization:

Thermal change causes a marked improvement in the properties of the soil. Thermal stabilization achieved by heating the soil or by cooling it.

a) Heating as the soil is heated, its water content decreases. Electric repulsion between clay particles is decreased and the strength of the soil is increased. When the temperature is increased to more than100degree, the adsorbed water is driven off and the strength is further increased. When the soil is heated to temperature of 400 degree to 600 degrees, some irreversible changes occur which make the sol non-plastic and non-expansive.the clay clods are converted into aggregates. this method of stabilization is quite expensive because of large heat input.
b) Freezing: cooling causes a small loss of strength of clayey soils due to an increase in inters particle repulsion. Water in cohesion less soils freezes at about 0 degree and in cohesive soils water may freeze at a much lower temperature. The strength of the soil increases as more and more water freezes. This method is commonly used only in some special cases like advancing tunnels or shafts through loose silt or fine sand. Freeze may cause serious trouble to adjacent structure if the freezing front penetrates these areas. It may cause excessive heaving.

2.7 Electrical stabilization:

Electrical stabilization of clayey soils is done by a process known as Electro-osmosis. As a direct current is

passed though clayey soil, pore water migrates to the negate electrode. It occurs because of the attraction of positive ions that are present in water towards cathode. The strength of the soil is considerably increased due to removal of water.
Electro-osmosis is an expensive method, and is mainly used for drainage of cohesive soils. Incidentally, the properties of the soil are also improved.

2.8 Stabilization by grouting:
In this method of stabilization, stabilizer is introduced by injection into the soil. As the grouting is a layer done under pressure, the stabilizers with high viscosity are suitable only for soil with high permeability.
The grouting method is costlier as compared with direct blending methods. The method is suitable for stabilizing buried zones of relatively limited extent, such as pervious stratum below a dam. The method is used to improve the soil that cannot be disturbed. An area close to an existing building can be stabilized by this method.
Grouting depend upon the stabilizer used, grouting techniques can be classified as under

- Cement grouting
- Clay grouting
- Chemical grouting
- Chrome-lignin grouting
- Polymer grouting
- Bituminous grouting

III. CONCLUSION

The application of soil stabilization can significantly improve the properties of soil to be used in the construction of roads and infrastructures. Results include a better and longer lasting road and structures with increased loading capacity.
As the technology development, many chemicals have been introduced into world, to introduce into sub grades to stabilize them. It required having some more advance If the stabilized soils contain organic matters, sulphates, sulphides and carbon dioxide, they try to reduce the strength of soils again. So, it is desirable for the invention of more stable and potential chemicals for soil stabilization.

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