SOIL STABILIZATION BY USING LIME AND FLYASH

Piyush Kumar Gupta[1] Shipra Chaubey[2] Ramesh Kumar Gupta[3] Abhishek Kumar Singh[4] Ankit Tripathi[5]

[1]Undergraduate, Civil Engineering Department, Buddha Institute of Technology,India
[2]Assistant Professor , Civil Engineering Department, Buddha Institute of Technology, India
[3]Undergraduate , Civil Engineering Department, Buddha Institute of Technology,India
[4]Undergraduate , Civil Engineering Department, Buddha Institute of Technology,India
[5]Undergraduate , Civil Engineering Department, Buddha Institute of Technology, India

ABSTRACT

Now days, inefficient properties of soils are a critical issue in engineering projects. In some cases, improve the characteristic of unsuitable soil is a fundamental step for making construction. Pavement structures on poor soil sub grades show early distress causing the premature failure of the pavement. Clayey soil usually have the potential to demonstrate undesirable engineering behavior , such as low bearing capacity , high shrinkage and swell characteristics and high moisture susceptibility. Stablilsation of these soil is a usual practice for improving the strength.Soil stabilization performed the use of technique to adding a binder to the soil in order to improve the engineering performance of soil .This study reports the improvement in the strength of a locally available cohesive soil by addition of both lime and fly ash. Researches were illustrated that adding the additives leads to progress in workability and mechanical behavior of soil after stabilization lime and fly ash as local natural and industrial resources were applied for chemical stabilization. Lime alone has traditionally been used in clay-bearing, highly cohesive soil whereas fly ash has been used to bind non-cohesive soil, granular or poorly cohesive soil. Fly ash is mainly used to stabilize the sub base or base course.

Key Words: Lime Fly ash and Soil

INTRODUCTION

The swelling and shrinkage characteristic of expansive soil depend upon the percentage of moisture content in it. So the expansive soil undergoes volumetric changes due to the variation of water content in it. The finer particles of the expansive soil lead to the water holding capacity. The percentage of moisture content inside the expansive soil depends upon the seasonal variation. The swelling and shrinkage characteristics of the expansive soil causes the differential movement, resulting in severe damaged to the foundations, buildings, roads, retaining structures, canal linings, etc. The expansive soil losses its chemical strength during the expansion condition. The fly ash generally produced by the combustion of coal of the thermal power plant. The large numbers of power plant has been established across the world to full fill the demand of power. Chemical stabilization introduced the use of technique to add a binder to the soil to improve the geotechnical performance of land such as mechanical and chemical characteristics of soil. Some studies are reported that, different additives such as cement, lime, fly ash, silica fume, and rice husk ash have been used for chemical stabilization of soft soils. Chemical stabilization is applied as a cost effective, environmental friendly and efficient method for soil treatment. It is also well known that stabilizing soil with local natural, industrial resources particularly lime and fly ash has a significant effect on improving the soil properties. In soil stabilization with lime and fly ash, additives combined by specific moisture content, then apply for improving the soil properties in engineering projects. Investigator experiments on the physical and chemical reaction of stabilized soil revealed that, lime, fly ash, and mixture of lime-fly ash have short-term and long-term effect on the characteristic of soil.

The objectives of the study are:-

1. Soil stabilization aims at improving soil strength and increasing resistance to softening by water through bonding the soil particles together, water proofing the particles or combination of the two.
2. The object of this project is to obtain an optimum percentage of lime or flyash which is most suitable.
3. Increasing the bonding between grains= increasing the mechanical strength.
4. This project is focused to stabilize the soil using lime and flyash.
5. Reducing the volume of voids = reducing the porosity.
6. Filling the voids that cannot be eliminated= reducing the permeability.

SOIL STRUCTURE

The clay particle in the soil structure is arranged in sheet like structures composed of silica tetrahedral and alumina octahedral. The sheet from many different combination, bt there are three types of formation the first is kaolinite, which consists of alternating silica and alumina sheets bonded together. This form of clay structure is very stable and does not swell appreciably when wetted the next form is montmorillonite, which is composed of two layers of silica and alumina sheet creating a weak bond between the layers. This weak bonding between the layers allows water and other cations to enter between the layers, resulting in swelling in the clay particles. The last type is illite, which is very similar to montmorillonite, but has potassium ions between each layer which help bond the layers together. Inter layer bonding illite is therefore stronger than for montmorillonite, but weaker than kaolinite.

Clay particles are small in size but have a large mass ratio, resulting in a larger surface area available for interaction with water and cations the clay particles have negatively charged surface that attract cations and polar molecules, including water forming a bound water layer around the negatively charged clay particles. The amount of water surrounding the clay particles is related to the amount of water that is available for the clay particle take in and release. This moisture change around the clay particles causes expansion and swelling pressure within clays that are confined.

MATERIAL USED

ALLUVIAL SOIL

The term alluvium is not typically used in situations where the formation of the sediment can clearly be attributed to another geologic process that is well described. This includes lakes sediments, river sediments or

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glacially-derived sediments. Alluvial soil is loose, unconsolidated soil or sediments which has been eroded, reshaped by water in some form, and re deposited in a non-marine setting.

LIME

Hydraulic lime is a general term for varieties of lime, or slaked lime, used to make lime mortar which set through hydration thus they are called hydraulic. Hydraulic lime provides a faster initial set and higher compressive strength. The terms hydraulic lime and hydrated lime are quite similar and may be confused but are not necessarily the same material. The two basic types of hydraulic limes are Natural hydraulic lime¬ Artificial hydraulic

FLYASH

Flyash is a by-product from burning pulverized coal in electric power generating plants. During combustion, mineral impurities in the coal fuse in suspension and float out of the combustion chamber with the exhaust gases. Two types fly ash are commonly used in concrete. Class c¬ Class F¬ Class c are often high-calcium fly ashes with carbon content less than 2 %;whereas class F are generally low calcium fly ashes with carbon content less than 5% but some times as high as 10%.In general, class c ashes produced from burning sub-bituminous are anthracite coals. Performance properties between class c and class f ashes are varying depending on chemical and physical properties of the ash. Many class c ashes when exposed to water will react and become hard just like cement but not class f ashes. Most, if not all, class f ashes will only react with the by-products formed when cement reacts with water. Class c and class f fly ashes were used in this research project.

METHODS USED

1) Mechanical Method:

In this category, soil stabilization in achieved by physical process such as alteration and mechanical machines.
By grading of soil particles i.e. changing composition of soil by adding or removing different soil particles.
By compaction using devices such as rollers, tempers, rammers.

2) Chemical Stabilization:

In this category, soil stabilization depends on chemical reaction between stabilizer and soil mineral. Granular soils lack stability when they are too dry. If their moisture content is stabilized by addition of some chemicals,then these soils can be used successfully .

Calcium Chloride

It is mainly used in road construction work for stabilizing base and sub base course.

Sodium Silicate

It is mainly used for fine and medium sands. Sodium silicate together with water and calcium chloride is injected for stabling soil deposit which improves the shear strength of soil.

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Cement

Cement being the oldest binding agent, is also considered as a primary stabilizing agent and is used to stabilize a wide range of soils. Stabilization process starts when cement is mixed with water, which results in hardening phenomena (hydration of cement). Setting of cement will enclose soil as glue, without changing the structure of soil.

Soil-lime Stabilization

Soil-lime is widely used either as modifier for clayey soil or as a binder. When clayey soil with high plasticity are treated with lime, the plasticity index is decreased and the soil becomes brittle and easy to be pulverized having less attraction with water. Lime also imparts some binding action.

In find grained soil lime imparts pozzolanic action which increases the strength. All these modifications are considered desirable for stabilization work.

Test methods:

Compaction

The tests were performed in accordance with ASTM D 1557. The specimens were of 102mm diameter and 116mm height. The degree of compaction of soil influences several of its engineering properties such as CBR value, compressibility, stiffness, compressive strength, permeability, shrink, and swell potential. It is, therefore, important to achieve the desired degree of relative compaction necessary to meet the required soil characteristics.

UCS

The UCS tests were performed in accordance with ASTM D 2166. The sample sizes were of 40mm diameter and 80mm length. At the Optimum Moisture Content (OMC) and maximum dry unit weight values of the natural soil, the tests were performed.

Test results and discussion:

Variation in water content of plastic limit test.

Admixture %	0	5	10	15
Water Content%	21.82	20.10	18.82	16.89

Variation in water content of liquid limit test

Admixture %	0	5	10	15
Water Content%	33.29	31.49	30.40	27.94

Variation in average water content and dry density

Admixture %	**0**	**5**	**10**	**15**
Water Content %	**14.26**	**17.32**	**15.87**	**11.57**
Dry Density gm/cc	**1.4552**	**1.4992**	**1.5585**	**1.6892**

Test unconfined compressive strength

Description	**Soil sample**	**Soil+ adm (5%)**	**Soil+adm (10%)**	**Soil+adm (15%)**
Sample dimension before test dia	**33**	**33**	**33.3**	**33.3**
Height (MM)	**71.2**	**71.2**	**71.3**	**71.4**
Wet density (KN/M3)	**18.51**	**18.46**	**17.53**	**16.47**
Water content (%)	**2.61**	**2.34**	**2.22**	**1.8**
Dry density (KN/M3)	**18.04**	**18.04**	**17.15**	**16.17**
Unconfined compressive test (KN/M2)	**2697**	**3533**	**2850**	**2160**

Conclusions:

1. Stress strain behavior of unconfined compressive strength showed that failure stress and strains increased by 106% and 50% respectively when the flyash content was increased from 0 to 25%.
2. When the lime content was increased from 0 to 12%, Unconfined Compressive Stress increased by 97%.
3. When the lime content was increased from 0 to 12%, CBR improved by 47%.
4. The optimum lime content was found at 12% for both UCS and CBR tests.
5. The swelling potential of expansive soil decreases with increasing swell reduction layer thickness ratio.
6. The vertical movement of clay soils with cushioning material stabilizes after 3 cycles of swelling and shrinkage.
7. An lime content of 12% and a flyash content of 25% are recommended for strengthening the expansive sub grade soil while a flyash content of 15% is recommended for blending into RHA to form a swell reduction layer.

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