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REVIEW ON SOIL STABILIZATION TECHNIQUE

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Abstract - Stabilization is a broad sense for the various methods employed and modifying the properties of a soil to improve its engineering performance and used for a variety of engineering works. In today's soil stabilization is the major problem for civil engineers, either for construction of road and also for increasing the strength or stability of soil and reduces the construction cost. Soil stabilization can be explained as the alteration of the soil properties by chemical or physical means in order to enhance the engineering quality of the soil. The main objective of the soil stabilization is to increase the bearing capacity of the soil, its resistance to weathering process and soil permeability. Due to rapid growth of urbanization and industrialization, minimization of industrial waste is serious problem in present days. To encounter this innovative and nontraditional research on waste utilization is gaining importance now a days. Soil improvement using the waste material like Slags, Rice husk ash, Silica fume etc. In geotechnical engineering has been recommanded from environmental point of view.

This paper reviews on the influence of blast furnace slag, fly ash and micro silica when used as admixtures with black cotton soil to improve various properties of soil.

Key Words: Stabilization, Fly Ash , Micro Silica , Blast Furnance Slag, C.B.R. , U.C.S. , B.C.Soil

1. INTRODUCTION

Civil engineering projects located in areas with soft soil is one of the most common problems in many parts of the world. The old usual method to soft soil stabilization is to remove the soft soil and replace it with stronger materials. The high cost of this method has driven the researchers to look for alternative methods and one of these methods is the process of the soil stabilization. Soil stabilization is the technique introduced many years ago with main purpose to render the soil capable of meeting the requirements of the specific engineering projects. In addition, when the soils at site are poor or when they have undesirable property making them unsuitable for use in a geotechnical projects, they may have to be stabilized.

The improvement of soil can be classified into several categories, modification or stabilization or both. The modification can be conducted by compaction or replacement of the original soil or mixing soil with another. While stabilization is the treatment of soils to enable their strength and durability to be improved such that they become totally suitable for construction. Many waste materials are used to modify the characteristics of soft soils. The soils are stabilized by lime, cement, fly ash etc. The engineering properties of soft soil subgrade layer may need to be improved to make such as soil good for construction by using stabilization method. Pavement subgrade stabilization relied on treatment with Blast furnace slag, cement, fly ash, and micro silica fume.

1.1 Methods:-

1. Mechanical Methods Of Stabilization:

In this procedure, soils of different gradations are mixed together to obtain the desired property in the soil.This may be done at the site or at some other place from where it can be transported easily. The last blend isthen compacted by the regular strategies to get the required thickness.

2. Additive Method Of Stabilization:

The addition of manufactured products into the soil, which in appropriate amounts improves the nature of thesoil. Materials such as cement, lime, bitumen, fly ash etc., are used as synthetic additives.

-It enhances the quantity of the soil hence, expanding the soil bearing limit.

-Stabilization enhances the workability and the strength of the soil.

- It helps in lessening the soil volume change.

1.2 Materials:

1) Blast Furnace Slag:-

Granulated Blast Furnace Slag (GGBS) Blast furnace slag is produced as a by-product during the manufacture of iron in a blast furnace. Molten blast furnace slag has a temperature of 1300-1600°C and is chilled very rapidly to prevent crystallization. The granulated material thus produced is known as granulated blast furnace slag. Blast furnace slag has a glassy, disordered, crystalline structure which can be seen by microscopic examination which is responsible for producing a cementing effect.

2) Fly Ash:-

Fly ash and bottom ash are part of combustion of non-combustible residue or combustion of sub-bituminous coal which had been generated in such a huge quantity in electric plants and they are by-product of burning coal that can be used without activators for soil stabilization.

3) Micro silica:-

Micro silica fume is an industrial waste produced from the smelting process of silicon metal and ferrosilicon alloy production. It contain high amount of extremely fine and amphrous size particles. Micro silica fume has been used in civil engineering works as a binder material in a combination with cement materials or individual for soil stabilization and given great results. Micro silica fume improves compressive strength, bond strength, abrasion resistance, and reduce permeability, and its available in two conditions: dry and wet.

2. LITERATURE REVIEW

2.1. Literature Paper No. 1

Amanpreet Tangri, Gagandeep "Effect of Blast Furnace Slag on Various Properties of Clayey Soil: A Review", International Journal for Scientific Research & Development, ISSN (online): 2321-0613, Vol. 6, Issue 03, 2018

In the present civil engineering world sometimes the foundation soil is not suitable for construction purpose. This creates lots of problem to civil engineer during the execution. To make the problematic soil suitable for engineering projects is known as ground improvement. So for the purpose of ground improvement we use numerous types of admixtures like cement, lime, blast furnace slag, rice husk ash, fly ash etc. This paper reviews on the influence of blast furnace slag when used alone or with some other admixtures on various properties of clayey soil. From the experimental results it has been found that by using blast furnace slag with admixtures like lime increases the value of U.C.S and C.B.R. and the variation is also found in the compaction characteristics of soil.

After doing a review of various research papers we can conclude the by using the blast furnace slag we can reduce the environmental pollution and it could be used for the stabilization of clayey soil. As we add Blast furnace slag the U.C.S and C.B.R value increases because cementation of soil by pozzolanic compounds produced during the reaction of soil with blast furnace slag

2.2. Literature Paper No. 2

J Bala Krishna, "Soil Stabilization with Flyash", International Journal of Research Sciences and Advanced Engineering, Volume 2, Issue 19, PP: 196 - 208, Jul – Sep:2017

This research work presents the efficacy of sodium based alkaline activators and class F fly ash as an additive in improving the engineering characteristics of expansive Black cotton soils. Sodium hydroxide concentrations of 10, 12.5 and 15 molal along with 1 Molar solution of sodium silicate were used as activators. The activator to ash ratios was kept between 1 and 2.5 and ash percentages of 20, 30 and 40 %, relatively to the total solids. The effectiveness of this binder is tested by conducting the Unconfined compressive strength (UCS) at curing periods of 3,7 and 28 days and is compared with that of a common fly ash based binder, also the most effective mixtures were analysed for mineralogy with XRD. Suitability of alkaline activated fly ash mix as a grouting material is also ascertained by studying the rheological properties of the grout such as, setting time, density and viscosity and is compared with that of common cement grouts. Results shows that the fluidity of the grouts correlate very well with UCS, with an increase in the former resulting in a decrease in the latter. In this work a new idea of stabilizing the expansive soil using alkali activated fly ash was discussed. The chemical sodium hydroxide and sodium silicate were used as a chemical activator for the fly ash. The method of sample preparation, proportion of chemical additive, curing of sample and changes in basic geotechnical properties of expansive soil

2.3. Literature Survey No. 3

Er. Rehana Rasool , Er. Kshipra Kapoor , "Comparative Study on Stabilization of Soil with Ground Granulated Blast Furnace Slag (GGBS)", International Journal of Latest Research in Science and Technology, ISSN (Online):2278-5299, Volume 6, Issue 3, May-June 2017

Utilization of industrial waste materials in the improvement of problematic soils is a cost efficient and also environmental friendly method in the sense that it helps in reducing disposal problems caused by the various industrial wastes. The main objective of the present study is to improve various engineering properties of the soil by using waste material Ground Granulated Blast Furnace Slag (GGBS) as an alternative to lime or cement, so as to make it capable of taking more loads from the foundation structures. This paper includes the evaluation of soil properties like unconfined compressive strength test and California bearing ratio test. The soil sample was collected from Lalru and addition to that, different percentages of GGBS (0%, 6%, 12 %, 18 % and 24%). was added to find the variation in its original strength. Based on these results CBR test was performed with the GGBS percentages (0%, 6%, 12 %, 18 % and 24%). From these results, it was found that optimum

GGBS (18%) gives the maximum increment in the CBR value compared with all the other combinations.

The study has been conducted to assess the potential of GGBS for stabilization of the same nature of soil. Use of slag as an admixture for improving engineering properties of the soils is an economical solution to use the locally available poor soil.

2.4. Literature Survey No. 4

S.W.Thakare, Priti Chauhan, "Stabilization of Expansive Soil with Micro Silica, Lime and Fly Ash for Pavement", International Journal of Engineering Research, ISSN:2319-6890(online), 2347-5013(print), Volume No.5IssueSpecial1pp:09-13 8 & 9 Jan 2016

Geotechnical Engineering properties of soft clayey soil deposits such as black cotton soil may need to be improved by stabilization to make such soils suitable for construction of road pavements. Stabilization of such soils has been traditionally relied on treatment with lime, cement and waste materials such as fly ash. Micro silica is waste material obtained from electric arc furnaces. This paper presents the results of stabilization of local black cotton soil with lime, fly ash and micro silica. Series of laboratory tests have been conducted with varying percentage of these stabilizers, added individually and in combinations, to determine their optimum percentages. From the results, it is observed that CBR value, for both soaked and unsoaked conditions, increases substantially by addition of 5% micro silica along with 3% fly ash and 3% lime. The pavement designed with these improved values of CBR indicated a marked reduction in its thickness leading to economy in the construction of road pavements on or using soft clayey soils.

Stabilization of black cotton soil with lime, fly ash, lime and their combinations shows significant improvement in the unconfined compressive strength of soil to the extent of 3.8 times that of unstabilized soil. Optimum percentages of micro silica, lime and fly ash for stabilizing black cotton soil are found to be 5%, 3% and 3% respectively. Black cotton soil stabilized with lime, fly ash, micro silica and their combinations shows noticeable improvement in soaked CBR of soil up to extent of 6.5 times of unstabilized soil. Black cotton soil stabilized with lime, fly ash, micro silica and their combinations shows noticeable improvement in unsoaked CBR of soil up to extent of 1.8 times of unstabilized soil.

2.5. Literature Survey No. 5

Dayalan J, "Comparative Study On Stabilization of Soil With Ground Granulated Blast Furnace Slag (GGBS) and Fly Ash", International Research Journal of Engineering and Technology, e-ISSN: 2395 -0056, p-ISSN: 2395-0072, Volume: 03 Issue: 05 , May-2016

Stabilization is a broad sense for the various methods employed and modifying the properties of a soil to improve its engineering performance and used for a variety of engineering works. Soil stabilization has become the major issue in construction engineering and the researches regarding the effectiveness of using industrial wastes as a stabilizer are rapidly increasing. This study briefly describes the suitability of the local fly ash and ground granulated blast furnace slag (GGBS) to be used in the local construction industry in a way to minimize the amount of waste to be disposed to the environment causing environmental pollution. In this present study, different amount of fly ash and GGBS are added separately i.e. 5, 10, 15 and 20% by dry weight of soil are used to study the stabilization of soil. The performance of stabilized soil are evaluated using physical and strength performance tests like specific gravity, atterberg limits, standard proctor test and California Bearing Ratio (CBR) test at optimum moisture content. From the results, it was found that optimum value of fly ash is 15% and GGBS is 20% for stabilisation of given soil based on CBR value determined.

The study has been conducted to assess the potential of fly ash and GGBS for stabilization of the same nature of soil. It is observed that with the increases of fly ash and GGBS percentage, optimum moisture content goes on decreasing while maximum dry density goes on increasing, hence compact ability of soil increases and making the soil more dense and hard.

2.6. Literature Survey No. 6

Abdelzaher E. A. Mostafa, Mohamed. S. Ouf and Mokhtar F. Elgendy "Stabilization of Subgrade Pavement Layer Using Silica Fume and Nano Silica" International Journal of Scientific & Engineering Research, Volume 7, Issue 3, March-2016

Many investigations have been carried out on clay subgrade soil; using several types of stabilizers. Due to the increase in traffic loads and the importance of subgrade layer in strengthen the pavement section to prevent the earlier damage. In this study the first step (based on the designed experimental program) samples were prepared with and without any additives; the used additives were lime (L), silica fume (SF), and nanosilica (NS). The tried percentages of lime were 2, 4, 6 and 8% and 5, 10 and 15% for SF, while 1, 2 and 3% used for NS. The second step was to examine the physical and mechanical properties of the prepared mixes using modified proctor test, Atterberg limits test, free swelling (FS%) test, unconfined compressive strength (UCS) and California Bearing Ratio (CBR) tests. Finally, direct shear (DS) test was carried out on the optimum mixes from the second step. All mixes were tested after two curing periods 7 and 28 days using UCS and FS%. The results indicated that the optimum moisture content (OMC) increased, while the maximum dry density (MDD) dramatically decreased for all used additives and plasticity index (P.I) decreased. The FS% decreased, and the maximum reduction in FS% was occurred at the two combinations (8% L + 15% SF) and (8%L+3%NS).

The UCS increased by adding both SF and NS activated by lime to the test soil , and the optimum percentages of the two combinations were occurred at 6%L+10%SF and 6%L+3%NS for traditional and nanomaterials additives respectively. So, control samples and the two optimum combinations have been prepared for CBR and DS tests. The DS test was carried out at dry and submerged conditions, while CBR test was carried out at soaked condition. The results indicated that the maximum value of CBR occurred at 8% L + 10% SF, while DS results indicated that adding 6L+10SF and 6L+3NS, the soil parameters (cohesion and internal friction angle) have been improved

2.7. Literature Survey No. 7

Anil Kumar Sharma, P.V. Sivapullaiah , "Ground granulated blast furnace slag amended fly ash as an expansive soil stabilizer" The Japanese Geotechnical Society Soils and Foundations, 2016; 56(2):205–212

The potential of using a binder for stabilization of expansive soils that consists of a mixture of fly ash and ground granulated blast furnace slag (GGBS) is evaluated in this study. The joint use of these two materials to form a binder provides new opportunities to enhance pozzolanic activities that may reduce the swell potential and increase the unconfined compressive strength of expansive clays. The influence of different percentages of binder on the Atterberg limits, compaction characteristics and unconfined compressive strength of an artificially-mixed soil were examined. The addition of binder was shown to bring about a significant improvement in these soil properties. It was found that the liquid limit and plasticity index of the expansive soil decreased considerably with the addition of binder, while the strength improved. Adding a small amount of lime (one percent) further improved the soil properties by enhancing the pozzolanic reactivity of the binder. Based on the results of the unconfined compressive strength tests, the addition of 20% binder is recommended as optimum content. In addition, the mineralogical and morphological studies of soil specimen stabilized with optimum binder content suggested the formation of hydrated particles and cementitious compounds as a result of the reaction between the clay and the binder. Test results indicate that the use of GGBS mixed fly ash as binder to stabilize expansive is well suited for sustainable construction besides economic benefits.

In this study, an artificially-mixed expansive soil was stabilized with different amounts of binder, primarily consisting of fly ash and GGBS at a mixing ratio of 7:3. The objective of this research was to assess the effect of fly ash-GGBS based binder on the physical properties and unconfined compressive strength of the soil.

2.8. Literature Survey No. 8

Chhaya Negi , R.K.Yadav , A.K. Singhai, "Effect of Silica Fume on Engineering Properties of Black Cotton Soil", International Journal of Computational Engineering Research, Vol, 03, Issue, 7.

Due to rapid growth of urbanization and industrialization, minimization of industrial waste is serious problem in present days. To encounter this ennovative and nontraditional research on waste utilization is gaining importances now a days. Soil improvement using the waste material like Slags, Rice husk ash, Silica fume etc., in geotechnical engineering has been recommanded from environmental point of view. The main objective of this study is to evaluate the feasibility of using Silica fume as soil stabilization material. In this paper the effect of Silica fume on engineering characteristics of expansive clay like Black Cotton Soil has been presented. A series of laboratory experiment has been conducted on black cotton soil blended with Silica fume content from 5% to 20% by weight of dry soil. The experimental results showed a significant increase in California bearing ratio and Unconfined compressive strength. The Differential free swell of the clay is reduced from 50% to 7% with increase in Silica fume content from 0% to 20% respectively. The Proctor compaction results showed a small decrease in Maximum dry density and increase in Optimum moisture content. From this investigation it can be concluded that the Silica fume as a potential to improve the characteristics of black cotton soil.

The BC soil-Micro Silica change the proctor compaction parameters. The addition of silica fume to the black cotton soil increase the optimum moisture content and decreases the maximum dry density with the increase in silica fume content. The addition of silica fume to the black cotton soil improve the soaked CBR considerably. The addition of 20% silica fume to the black cotton soil increases the CBR strength by 72% approximately. There is a significant decrease in the swelling characterristics of the soil. The degree of expansiveness reduceses from "High to Low"

3. CONCLUSIONS

After doing a review of various research papers we can conclude the by using the blast furnace slag we can reduce the environmental pollution and it could be used for the stabilization of clayey soil. The primary benefits of using these additives for soil stabilization are Cost Savings: because slag is typically cheaper than cement and lime; and Availability: because slag sources are easily available across the country from nearby steel plants. Waste management one of the industrial wastes can be done economically. Use of slag as an admixture for improving engineering properties of the soils is an economical solution to use the locally available poor soil.

Stabilization of black cotton soil with lime, fly ash, lime and their combinations shows significant improvement in the unconfined compressive strength of soil to the extent of 3.8 times that of unstabilized soil.

It is observed that with the increases of fly ash and GGBS percentage, optimum moisture content goes on decreasing while maximum dry density goes on increasing, hence compact ability of soil increases and making the soil more dense and hard

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