International Journal of Advanced Technology in Engineering and Science
Vol. No.5, Issue No. 01, January 2017
www.ijates.com
ijates
ISSN 2348 - 7550

"STABILIZATION OF PLASTIC SOIL USING MARBLE DUST, RICE HUSK AND FLY ASH": Review

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ABSTRACT

An environment friendly and cost effective way of soil stabilization is with the help of industrial waste. Unsuitable highway subgrade, foundation soil of heavy building or water reservoirs etc. requires stabilization to improve its engineering properties. Large areas are covered with highly plastic soil, which is not suitable for construction purpose. In urban areas, borrow earth is not easily available which has to be hauled from a long distance. Instead of borrowing a suitable soil from long distance it is economical to use locally available plastic soil after stabilization with cost effective and easily available industrial wastes. In this present study, components used are marble dust which is an industrial waste product, fly ash and rice husk which are agricultural waste products. The project is planned to conduct various geotechnical lab test like unconfined compressive strength test, shrinkage test, swelling test, permeability test, Atterberg limit and shear strength test. The objective of this study is to evaluate the effect of materials used to enhance the properties of plastic soil by comparing with the results and graphs of various mixes. This stabilization technique is cost effective and has an additional benefit of providing an environmental friendly way to deal with industrial waste product.

Keywords: Marble dust, rice husk, fly ash, unconfined compressive strength.

I. INTRODUCTION

Soil stabilization is the process of improving the engineering properties of the soil and thus making it more stable. It is required when soil available for construction is not suitable for the intended purpose. In the broad sense, stabilization includes compaction, pre-consolidation, drainage and many other such processes. Stabilization is the process of blending and mixing materials with a soil to improve certain properties of the soil. The process may include the blending of soils to achieve a desired gradation by the mixing of commercially available additives that may alter the gradation, texture or plasticity, or act as a binder for cementation of the soil. Soil stabilization is used to reduce the permeability and compressibility of the soil mass in earth structures, to reduce the swell in case of expansive soils and to increase its shear strength. Soil stabilization is required to increase the bearing capacity of foundation soils.

Due to the increasing cost of high quality materials needed for different geotechnical projects, engineers try to improve the physical properties of local soils through different methods and techniques. The word improvement means to increase the shear strength, reduce settlement, resist harsh environment conditions such as thawing and freezing, and decrease or eliminate all problems associated with weak soils. Soil stabilization could be applied to both sandy and clayey soil through mechanical and chemical methods. There are many common methods-mechanical or chemical-found in the literatures that were used to improve the physical properties of the soils.

While considering the aspects of building construction, problematic soils such as soft clays can cause substantial distress and excessive settlement to overlying structures and infrastructure because of their low shear strength and high compressibility.

Hence appropriate measures are to be taken for the improvement of properties of soils, preferably before conducting construction work. A wide range of soil improvement methods has been used, including soil replacement, dynamic compaction, lime/cement columns, stone columns, and soil reinforcements with fibrous materials. The selection of an appropriate method depends on ground characteristics, effectiveness, and practicality of the preferred technique and associated costs.

The stabilization with cement and lime is well documented. Soil stabilization using cement is not generally preferable because of the increasing cost and environmental concerns related to it like the CO2 emission during its production. Production of lime also causes the emission of CO2. Moreover lime contains sulphates which may increase swelling due to formation of swelling minerals such as ettringite and thaumasite. Over the last few years, use of industrial wastes like blast furnace slag, fly ash, rice husk ash, steel slag, marble dust, bagasse ash, ceramic tile waste etc. has increased as stabilizing materials for naturally occurring fine-grained soils. These waste products pose a serious environmental problem if not disposed of properly. Their use serves two purposes; firstly the disposal of waste material and secondly, use as construction material.

The purpose of present study is to see the effect of industrial wastes; marble dust, fly ash and rice husk waste in improving compressibility characteristics of an expansive soil. A better understanding of these characteristics will enhance the usage of these materials in geotechnical engineering works in places where they are abundant and thereby making clays suitable for foundation purpose. The study also focuses at reduction of huge stockpile of the various industrial wastes and their potential impact on the environment.

In India, large areas are covered with highly plastic soil which is not suitable for civil engineering purpose. In urban areas to borrow earth is not easily available which has to be hauled from a long distance. Instead of borrowing suitable soil from a long distance it is economical to use locally available plastic soil after stabilization.

Construction activities on plastic soil require the stabilization of soil prior to the start of work. Some of the stabilization methods include soil replacement, dynamic compaction, lime/cement columns, stone columns, and soil reinforcements with fibrous materials.

Proper investigation of soil profile beneath the proposed structure as well as proper designing of structures on the basis of shear strength and settlement criteria is a must. In the present work, compressibility characteristics have been studied of a plastic soil treated with different percentages of industrial wastes by conducting a series of geotechnical lab tests.

II. REVIEW OF LITERATURE

2.1 Review of literature (Fly Ash)

Amu et al. (2005) [1] had used (Class- F) fly ash and cement for stabilization of expansive soil. It was found that stabilizing effect of 9% cement and 3% fly ash was better than the stabilizing effect 12% cement.

Cokca (2001), Nalbantoglu (2004), Pandian and Krishna (2003) and Mishra et al.(2005) had studied effect of class-

C fly ash on different engineering properties of expansive soil and had found varied success.

Sharma and Gupta (2013) had investigated the effect of fly ash(class-F) on sand stabilized black cotton soil based on compaction and CBR test the optimum proportion of soil: sand :fly ash was found to be 63:27:15.

2.2 Review of literature (Rice husk)

Muntohar and Hantoro (2000) had studied the stabilizing effects of RHA and lime on engineering properties of expansive soil and had found improvement in engineering properties like IP, CBR, shear strength parameters, Sp etc.

Basha et al. (2003) [2] had studied the effects of RHA and cement on plasticity and compaction properties of expansive soil (bentonite) and had recommended that 10-15% of RHA and 6-8% of cement as optimum percentages for stabilization.

Ramakrishna and Pradeep Kumar (2006) [3] had studied combined effects of RHA and cement on engineering properties of black cotton soil. From strength characteristics point of view they had recommended 8% cement and 10% RHA as optimum dose for stabilization.

2.3 Review of literature (Marble dust)

Panagiotis Ch. Eskioglou (2009) examined the adequacy of marble dust as a soil stabilizer. The study revealed that the geotechnical parameters of black cotton soils are enhanced significantly by the addition of marble dust. Huge plasticity index reductions happened with marble dust treatment, particularly for high PI soils. Results demonstrated that plasticity decreased by 15 to 30% and strength increased by 25 to 50 %. The most noteworthy strength increase was accomplished at 8% marble dust after 28 days. Increments in the unconfined compressive strength of soil occurred with the addition of marble dust.

Akshaya Kumar Sabat, Radhikesh P. Nanda (2011) [4] examined the impact of marble dust on strength and durability of rice husk ash stabilized expansive soil and found that addition of marble dust increases the strength, decreases the swelling pressure and made the soil rice husk ash mixes strong. The ideal mixture of soil: rice husk ash: marble dust was observed to be 70:10:20.

R. Ali, H. Khan, A. A. Shah (2012) [5] utilized marble dust and bagasse ash for expansive soil improvement. Different laboratory tests on expansive soil without the addition of these wastes and with the addition of these waste were conducted and their impact on swelling and different properties were determined.

Sachin N. Bhavsar, Hiral B. Joshi, Priyanka K. Shrof, Patel Ankit J. (2013) evaluated swelling potential of expansive soil in its natural state as well as when mixed with varying proportion of marble dust (from 30 to 50%). It is concluded that the impact of marble powder on black cotton soil is positive. It gives maximum improvement in the swelling and linear shrinkage properties of black cotton soil.

Rozhan Sirwan Abdulla, Nadhmiah Najmaddin Majeed (2014) investigated the soil from two spots Bastora and Erbil Airport with Bastora soil as CH soil and Erbil Airport as CL soil. The marble waste powder was included in percentages of 10%, 20% and 30% by weight of soil. The results demonstrate that increase in percentage of marble dust decreases liquid limit, plasticity index and plastic limit and swelling potential.

III. EXPERIMENTAL INVESTIGATIONS

Z.1 Materials used

3.1.1 Plastic clay soil

Soil used in the experiments has been collected from a village near Dayalpur located in Kurukshetra (Haryana). The soil is classified as silty clay, CI-MI, as per IS: 1498 (1970)

3.1.2 : Fly Ash

Fly ash by itself has little cementations value but in the presence of moisture it reacts chemically and forms cementations compounds and attributes to the improvement of strength and compressibility characteristics of soils. It has a long history of use as an engineering material and has been successfully employed in geotechnical applications.

3.1.3: Rice Husk

Rice Husk Ash (RHA) is obtained from the burning of rice husk. The husk is a by-product of the rice milling industry. By weight, 10% of the rice grain is rice husk. On burning the rice husk, about 20% becomes RHA. Some of the investigative studies in which these materials have been used are described below:

3.1.4 Marble dust

Marble dust was procured from a locally available marble cutting and polishing industry. It is non-plastic with a specific gravity value of 2.69. The chemical properties of marble dust as reported in literature have been given in Table 4.3.

Table 4.3: Chemical properties of a typical marble dust

IV. EXPERIMENTAL TESTS

4.1 Standard Proctor Tests

Standard Proctor tests were conducted to determine optimum moisture content and maximum dry density of parent soil and soil stabilized with 3, 6, 9, 12 and 15% of various industrial waste materials passing 425 micron IS sieve.

These tests were conducted in order to prepare specimens at maximum dry density by adding desired optimum moisture content as per specifications of IS: 2720 (Part 7) (1974). The results of

4.2 Liquid limit test

Liquid limit test was conducted by using casagrandae apparatus as per specifications of IS: 2720 (Part 4) 1970

4.3 Shrinkage limit test

Shrinkage limit test was conducted as per specifications of IS: 2720 (Part 4) 1972.

4.4 Plastic limit test

Plastic limit test was conducted as per specifications of IS: 2720 (Part 4) 1970.

4.5 Unconfined compression test

UCS test on silty clay treated with different percentage of rice hush, fly ash and marble dust as per specifications of IS: 2720.

V. SAMPLE PREPARATION

5.1 Composition of specimens

Specimens of parent soil and soil treated with 0, 5, 10, 15, 20% by weight of various industrial waste materials passing 425 micron IS sieve will be prepared at maximum dry density and optimum moisture content as per IS: 2720 (Part 7) (1974).

5.2 Mixing

Oven dry soil will be dry mixed with various percentages of additives. Sufficient quantity of distilled water will then be added to bring the moisture content to the desired level. The mixture will then be manually mixed thoroughly with a spatula. All the specimens will be kept in polythene bags for maturing for three days.

5.3 Compaction

Specimens will be compacted by static compaction in 10 cm diameter consolidation ring to the required height of 2.5 cm. The inner surface of the ring will be smeared with mobile oil to help minimize friction between inner surface of the ring and the soil sample. The wet homogenous mixture will be placed inside the specimen ring using a spoon in three layers, leveled and gently tap-compacted by 5cm diameter ram. Sample will be placed in specimen ring with extension collar attached to it and both the exposed sides of the sample will be covered with saturated filter papers. After that porous stone and pressure pad will be inserted into the extension collar and the whole assembly will be statically compacted in loading frame to the desired density. The sample will be kept under static load for not less than 10 minutes in order to account for any subsequent increase in height of sample due to swelling.

VI. CONCLUSION

The optimum percentage of rice husk ash, fly ash and marble dust in stabilization of soil is found out be 10%, 8% and 20%. The Soaked unconfined compression strength of the rice husk ash stabilized expansive soil increased up to 20% addition of Marble dust. Further addition of Marble dust decreased the soaked unconfined compression strength of the expansive soil. The unconfined compression strength of the given soil sample has increased 14% in further addition of the fly ash content. This method of soil stabilization is very effective and economical in the stabilization of silty clay soil.

REFERENCE

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