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Stabilization of Silty Soil Using Lime and Natural Pozzolana

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Abstract— *Poor engineering properties of silty soil create difficulties during construction and hence it is needed to improve its properties. This study investigates the use of lime or natural pozzolana with silty soil to improve its application. Laboratory tests will be performed to study the effect of natural pozzolana or lime on the physical and mechanical characteristics of silty soil.*

Keywords— laboratory tests, lime, silica, silty soil, stabilization.

I. INTRODUCTION

1.1 GENERAL:

Soil Stabilization is a general term used for any of the physical, chemical, or biological methods, or a combination of them, which is used for improvement of soil properties. Improvement of soil engineering properties is an inevitable necessity, when the structures are founded on a problematic soil. Expansive, collapsible, liquefiable, soluble, dispersive, silty soil fine sands and highly organic weak soils are the most serious kinds of problematic soils. Silty sand soils are kinds of problematic soils which found in different areas of the world and are susceptible to collapse when come in contact with water.

Soil improvement can be undertaken by a variety of ground improvement techniques such as compaction, reinforcement, drainage and addition to natural and synthetic materials or a combination of physical and chemical methods. Chemical stabilization or addition of different natural and synthetic material of soil has experienced in recent years. Lime, cement and pozzolanic materials are the most common construction materials which are extensively used for stabilization of soils. Recently different modern technologies such as nanoparticles were used for stabilization of soils.

There are many types of problematic soils that hinder urban development in large cities. These could be swelling/shrinking clays, collapsible soils, quick sands, frozen soils and peat. The consequences that may be attributable to the behavior of such problematic soils can result in considerable financial loss. Problematic soils have been avoided for long time for construction sites in favor of more quality soils with reduced technical difficulties and hence lower construction costs. Nowadays, it has become difficult to find suitable sites for construction and suitable materials for structures such as highways, dams or runways at an economic distance.

1.2 Stabilization of Silty Soil:

Lime and cement are the most used chemical stabilizers. Lime as an additive is most commonly used to stabilize fine soils due to its effectiveness and economic usage. Moreover, lime improves significantly the engineering properties of soft soils. Lime stabilization is achieved though cations exchange, flocculation/agglomeration reaction take place rapidly bringing immediate change in soil properties, whereas pozzolanic reactions are time dependent. These pozzolanic reactions involve interactions between soil silica and /or alumina and lime to form various types of cementation products responsible for the gain of strength.

In recent years, industrial by products have been added and mixed with soft soils to improve their engineering properties. The improved characteristics of soft soils, resulting from the utilization of cementing additives like fly ash, rice husk ash and silica fume, bring about environmental and economic benefits. The effectiveness of these by- products for stabilization of soils has been investigated.

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II. MATERIAL AND METHOD

2.1 Silty Soil:

The soil used in this project is collected from an excavation site in Shirgaon, virar-east, Mumbai-401303. The properties of silty soil collected are present in Tables 1 and 2. Silt is a sediment material with an intermediate size between sand and clay. Carried by water during flood it form a fertile deposite on valleys floor. The particle size of silt ranges from 0.002 and 0.06 mm. Silt is a non-plastic or low plasticity material due to its fineness. Due to its fineness, when wet it becomes a smooth mud that you can form easily into balls or other shapes in your hand and when silt soil is very wet, it blends seamlessly with water to form fine, runny puddles of mud.

2.2 Lime:

The lime used for the study is commercially available lime in hydrated form. Chemical analysis of the lime stated as the lime was assessed as 68.38%.

2.3 Natural Pozzolana:

Pozzolana is also known as pozzolanic ash, is a natural siliceous or siliceous-aluminous material which reacts with calcium hydroxide in the presence of water at room temperature. For the study silica is used it also consist of various other minerals containing calcium, magnesium, iron, potassium and sodium. A pozzolan's activity refers to both its capacity of binding lime and the rate at which the binding reaction takes place, therefore, it covers all the reactions taking place between the active components of the pozzolan, lime and water.

III. TEST AND RESULTS

3.1 Sieve analysis:

The distribution of different grain sizes affects the engineering properties of soil. Grain size analysis provides the grain size distribution and it is required in classifying the soil. The result obtained is as follows:

Table 1
Sieve analysis

Sieve number	Diameter (mm)	Mass of empty sieve (gm)	(Mass of sieve)+ (soil retained) (gm)	Soil retained (gm)	Percentage retained	Percentage passing
4	4.75	116.23	166.13	49.9	9.5	90.5
10	2.0	99.27	135.77	36.5	7.0	83.5
20	0.84	97.58	139.68	42.1	8.0	75.5
40	0.425	98.96	138.96	40.0	7.6	67.8
60	0.25	91.46	114.46	23.0	4.4	63.4
140	0.106	93.15	184.15	91.0	17.4	46.1
200	0.075	90.92	101.12	10.2	1.9	44.1
Pan	-	70.19	301.19	231.0	44.1	0.0
				Total wt.=523.7		

3.2 Moisture content:

The test conducted for calculating moisture content was carried out by oven dry method. The following is the result table noted after the test carried out.

Table 2
Oven drying method

Wt. of container, W_1(gm)	39.5
Wt. of container + wet soil, W_2(gm)	133.5
Wt. of container + dry soil, W_3(gm)	115.14
Wt. of moisture, (W_2-W_3) (gm)	18.36
Wt. of dry soil, (W_3-W_1) (gm)	75.64
Water content, $W=\frac{w2-w3}{w3-w1}\times 100$ (%)	24.27%

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IV. CONCLUSION

This project specify the properties of the material as well as source of the same. The various test are specified and perform in the lab and the results are as mentioned. The silty soil is very poor in mechanical properties it is must to stabilize the soil. Lime as well pozzolana will stabilize the soil and the test will be carried out on the sample comparing with the original sample. The project will give a stable mixture of the silty soil,pozzolana and lime. The plasticity index decreased with increasing lime contents. Moreover, when both natural pozzolana and lime were added to the cohesive soils, an appreciable change of the plasticity behaviour was observed. However, the addition of natural pozzolana has a minor effect on the plasticity index of the grey soil. Both grey and red soils tend to change according to the unified soil classification system. The use of lime alone and the combination of natural pozzolana-lime, transformed grey soil (CH) and red soil (CL) into MH class soils.

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