Influence of Blast Furnace Slag and Fly Ash on Strength Properties of Clayey Soil: A Comparative Study

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Abstract

Soil stabilization is a major problem in construction engineering and the researches are effectively using rapidly generating industrial wastes. This present experimental work describes about the stability of clayey soil with Blast furnace slag and Rice husk ash individually by using Lime. The main aim is to minimize the industrial waste generated by industry. The cost of stabilization by normally used common techniques has become costlier day by day such as cement, lime etc. So replacement of natural soils, aggregates with industrial by product is extremely desirable. This also reduces environmental hazards. In this study the unconfined compressive strength of clayey soil was studied by using Blast furnace slag and Rice husk ash. Lime was also mixed with both Blast furnace slag and Rice husk ash. In the starting of the study lime was optimized and the optimized amount of lime was found to be 4%. It was determined by performing unconfined compressive strength test and adopting the curing period of 7 days. Then this optimum amount was used for further study with Blast Furnace Slag and RHA on clayey soil for determining the unconfined compressive strength for both materials separately and using fixed amount of lime. Various percentages of Blast Furnace Slag and Rice Husk Ash were 10%, 20%, 30%, 40% and 50%. The unconfined compressive strength was found to be maximum at 10% RHA,4% lime and 86% of soil.

Keywords: Unconfined Compressive Strength, Blast Furnace Slag, Rice Husk Ash, Lime

INTRODUCTION

With the increasing growth of civilization they had forced engineers to use the site

which is not fit from view of a geotechnical engineer. In all civil engineering structures, clayey soils are not suitable as they generate problems. The structures found on this soil are subjected to deflections which cause distresses and may prove to be hazardous to structures. Reduction in moisture content cause shrinkage by the evaporation, The rise in water table has considerable effect on movement of foundation on clayey soil .If we built a structure during dry season, then base of foundation exhibit swelling pressure as partially saturated soil starts taking water during wet season. On the other side if the structure is built during the wet season, then in dry season it would experience settlement.Clayey soils due to their shrink swell behavior cause loss in soil strength and instability which could result into slope failure and foundation problems.

MATERIAL USED

SOIL

Soil used in this study was collected from a village Loharbaddi (distt- Ludhiana). The estimate amount of soil used in this study was 200 kg. The soil was sorted with hands to remove any pebbles and vegetative material from it. The soil was oven dried before using it for experiments. Table No 1 : Physical properties of soil were

Sr no.	Property of soil	Value
1	Liquid limit	36.65%
2	Plastic limit	21.35%
3	Plasticity index	15.30%
4	Classification of soil	CI
5	Specific gravity	2.56
6	O.M.C	19%
7	M.D.D	1.59 gm/cc
8	U.C.S	2.11 Kg/cm^2

LIME

The word "lime" originates from its earlier use as building mortar and has the property of "sticking or adhering". Lime is a term used for calcium-containing inorganic materials, in which carbonates, oxides and hydroxides predominate. Generally lime is calcium oxide or calcium hydroxide.These materials are extensively used in construction from a long time. It is also used for waste water treatment plants with ferrous sulphate.

BLAST FURNACE SLAG

Blast furnace slag has cementious properties and it is generally used with cement or lime. The temperature of molten blast furnace slag

is 1300-1600º C. it is chilled rapidly for prevention of crystallization.

According to American Society for Testing and Materials Blast furnace slag is defined as a non-metallic product which consist of alumino silicates of calcium or other bases and is developed in molten condition with iron in a blast furnace. It is inorganic in nature.

RICE HUSK ASH

It is reported that 1ton rice husk produced from every 4ton of rice. World produced approximately 500 million tons rice in every year. After burning the rice hull produced about 15%-20% of its weight as ash. Rice husk ash is very light weight and it easily carried by water and wind hence contributing to environmental pollution. The large quantity of rice husk ash produced requires huge areas for disposal. Rice husk ash is a pozzolanic material.

RESULT AND DISCUSSIONS

UNCONFINED COMPRESSIVE STRENGTH TEST

This is the most adaptable method for evaluating the strength. The U.C.S test was conducted on lime and soil. The curing period adopted was 7 days.

Table No: 2 : Variation of U.C.S with percentage of Lime after 7 Days curing

Sr.no	Proportion	U.C.S (Kg/cm^2)
1	Virgin soil	2.11
2	L:S = 2:98	4.86
3	L:S = 4:96	7.10
4	L:S = 6:94	8.82
5	L:S = 8:92	9.48

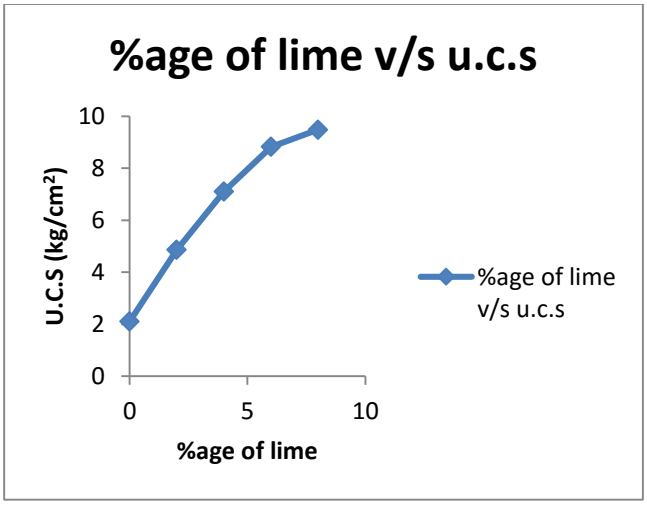

Figure No: 1 : Variation of U.C.S with percentage of Lime

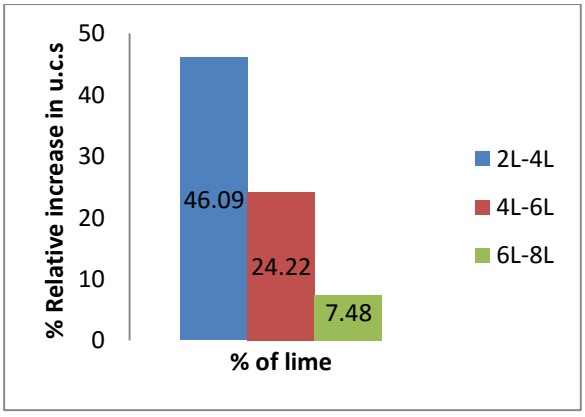

Figure No:2 Percentage relative increase in U.C.S with increase in percentage of lime

From the Figure no. 1 and 2 and table no 2 it is found that percentage relative increase in strength was maximum between 2% to 4%. Hence 4% lime was taken as the optimized amount. The increase in U.C.S due to addition of lime to soil may be due to pozzolanic reactions between alumina or silica from clayey soil and lime, which forms the cementious products. For further study 4% lime was used.

Table No: 3 Variation of U.C.S with various percentages of Blast Furnace Slag

Sr.No.	MIX PROPORTION	CURING PERIOD (DAYS)	U.C.S (Kg/cm^2)
1	L:BFS:S = 4:10:86	7	5.24
		14	8.88
		28	10.56
2	L:BFS:S = 4:20:76	7	6.64
		14	12.56
		28	14
3	L:BFS:S = 4:30:66	7	7.1
		14	14.66
		28	17.27
4	L:BFS:S = 4:40:56	7	6.81
		14	13.49
		28	14.25
5	L:BFS:S = 4:50:46	7	5.37
		14	11.28
		28	11.76

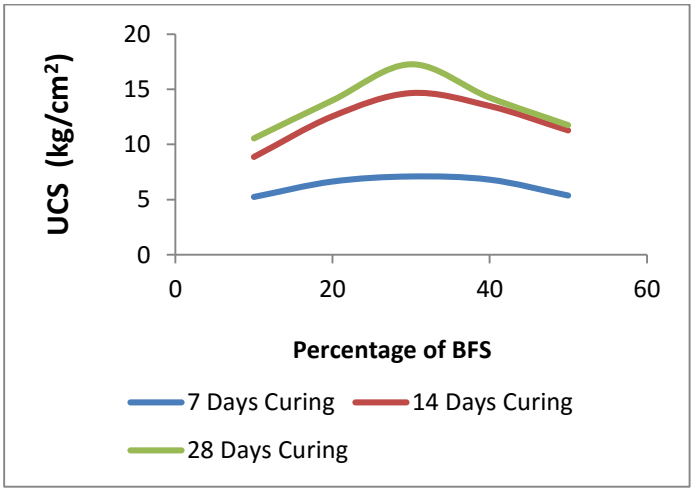

Figure No: :3 Variation of U.C.S with percentage of BFS

It was found fom Table no. 3 and figure no.3 the U.C.S value increases up to 30% BFS. After that there is decrease in the value. The reason behind this is because of excess BFS added to the soil and therefore weak bonds are formed between the soil and the cementious products and the low strength provided by BFS. The other reason behind it may be that the lime provided is insufficient for pozzolanic reactions.

Table No: 4 Variation of U.C.S with various percentages of Rice Husk Ash

Sr. No.	Proportion of RHA	Curing Period	U.C.S. (kg/cm^2)
1	S:RHA:L = 86:10:4	7	11.966
		14	15.625
		28	22.527
2	S:RHA:L = 76:20:4	7	10.632
		14	14.915
		28	20.546
3	S:RHA:L = 66:30:4	7	7.176
		14	9.448
		28	12.784
4	S:RHA:L = 56:40:4	7	5.352
		14	6.24
		28	8.286
5	S:RHA:L = 46:50:4	7	3.205
		14	4.379
		28	5.563

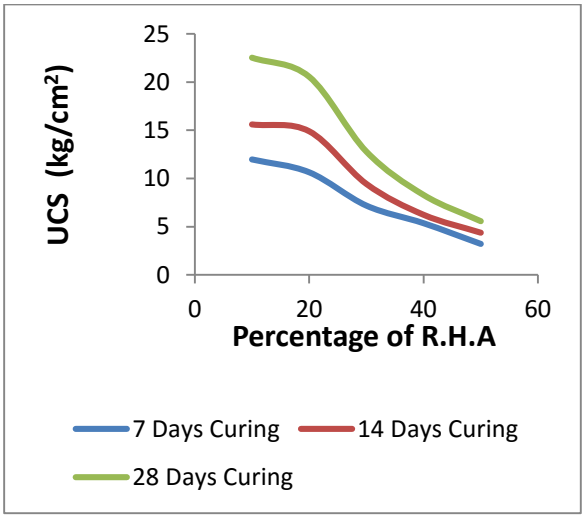

Figure No: 4: Variation of U.C.S with percentage of RHA

It was found from Table no. 4 and figure no.4 the U.C.S value on addition of 10% RHA content with 4% lime is more effective at every curing period. After which further addition of RHA content does not contribute towards strength at any curing period. RHA cannot be used alone for the stabilization of soil due to lack of cementitious properties. Unconfined compressive strength increases with increasing curing period in both the cases. The reason behind increase in strength with increase in curing period is due to various reactions related to the strength gain in the mix. Various reactions responsible for this is hydration, pozzolanic reactions and carbonation.

In RHA and soil, additional amount of silica is available, it reacts with lime resulting in further increase of strength. Due to this the unconfined compressive strength by addition of RHA is greater than Blast furnace slag. Beyond the optimum value of RHA does not lead to strength. The reason may be low strength by RHA alone and low specific gravity of RHA.

CONCLUSIONS :

1. From the results obtained the optimized value of lime was found to be 4%. This was used for further study with BFS and RHA.
2. The U.C.S of Lime-Blast furnace slag- Soil mix increases from 10% to 30% of blast furnace slag and then follows decreasing trend up to 50%.
3. The U.C.S of Lime-RHA- Soil mix decreases from 10% to 50% of RHA.
4. The optimized mix suitable for this soil is L: RHA: S = 4: 10: 86.

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