Study on Soil-Admixture Stabilization using Cement, Fly ash, Rice husk and Stone dust

Raghunandan M H[1], Lakshmi C[2]

[1]*Assistant Professor, Dept. of Civil Engineering, M S Engineering College – Bengaluru, Karnataka, India*
[2]*Associate Professor, Dept. of Civil Engineering, S J B Institute of Technology – Bengaluru, Karnataka, India*

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Abstract - *Construction of any structure over a weak soil is highly difficult on the geo-technical grounds as the soil undergoes differential settlements, high compressibility and poor shear strength. Generally, the type of foundations depends upon the availability of soil strata as well as cost. But sometimes there will be necessity to have a high rise structures over a weak soil, in such conditions improvement of load bearing capacity of soil is very much necessary. In these aspects soil stabilization can be done by various techniques. Generally, admixing technique has an effective improvement because it can be easily adaptability. Therefore, the present investigation describes the behavioral aspect of soils mixed with admixtures to improve the load bearing capacity of the soil. The main objectives of the present investigation is to assess the usefulness of cement, fly-ash, stone-dust, rice-husk as a soil admixture, and focused to improve the engineering properties of soil to make it capable of taking more load from the foundation structures. This study also benefits the effective use of fly-ash, stone-dust, rice-husk and thus cost effective method for improving the soil properties.*

Key Words: Stabilization, Admixture, Cement, Fly-ash, Stone-dust, Rice-husk etc.

1. INTRODUCTION

Stabilized soil is a composite material that results from combination and optimization of properties in individual constituent materials. The techniques of soil stabilization are often used to obtain geotechnical materials improved through the addition into soil of such cementing agents. The replacements of cement with solid waste by-products are highly desirable. But in some cases the by-products are inferior to traditional materials, however due to its lower cost they can be used alternatively if adequate performance is obtained. Stabilization of soil with some kind of additive is common the degree of alternation depend on the nature of the soil and its deficiencies. A satisfactory additive for stabilization must have the desired qualities and must meet the requirements such as compatibility with the soil material, easy handling and processing, low cost and safe.
The shear strength of soil can be improved by addition of fly ash. Fly ash in soil can be effectively used as the base materials for the roads, back filling, roads and improving the bearing capacity of any soil [1]. Rice-husk can stabilize the soil, either solely or when mixed with cement. It can be alternatively adopted to reduce construction cost, particularly in the rural area [3].
The main objectives of the present investigation is to assess the usefulness of fly ash, stone dust, rice husk as a soil admixture and focused to improve the engineering properties of soil to make it capable of taking more load from the foundation structures.

1.1 Materials and Methods

Sampling of soil is done at Hebbal Lake, which is located in the north of Bangalore at the mouth of National Highway-7, as area of this lake is decreasing year to year and is used as construction site. But before any construction work the characteristics of soil need to be known and further the weak soil needs to be stabilized. Here disturbed soil sample is collected from about 0.5-1 m below the ground surface, also measures are taken to see that natural water content is preserved.

Addition of cement to the soil provides good bonding between the soil grains and helps in increasing the soil strength. The cement used for our investigation is ordinary Portland cement of 53-grade. In India, approximately 100 million tonnes of fly ash are being generated per year and it is very difficult task to dispose due to environmental related issues. But we can make use of this fly ash in various construction fields where soil stabilization is also one to reduce the disposal problem of fly ash. Fly ash for our investigation is taken from a standard RMC plant. Rice husk was considered as valueless by-product of rice milling. This rice husk is made in the form of powder to attain homogenous mix and used as admixture in soil stabilization. Stone dust is one of the by-products obtained from quarrying of rocks which is useless, but it can be used in many ways under economic aspects.

A series of laboratory tests were conducted to know the preliminary characteristics of soil followed by the use of admixtures in different proportions to know the change in behaviour of soil treated with admixtures. Finally on comparing the results obtained suitable admixture and proportion is determined.

2. RESULTS AND DISCUSSIONS

Before conducting the actual testing methods we should know the important Index properties and initial Engineering properties of the soil sample taken for study. So, some of the tests such as Atterberg's limit, Compaction test and Unconfined Compression tests were conducted initially to know the classification of soil.

2.1 Preliminary Testing

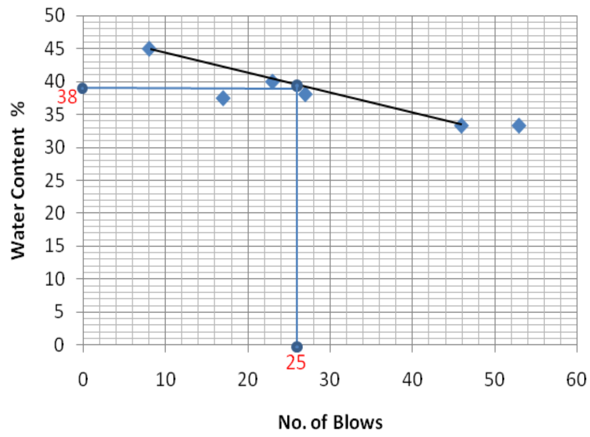

Chart – 1: Liquid limit graph of preliminary soil

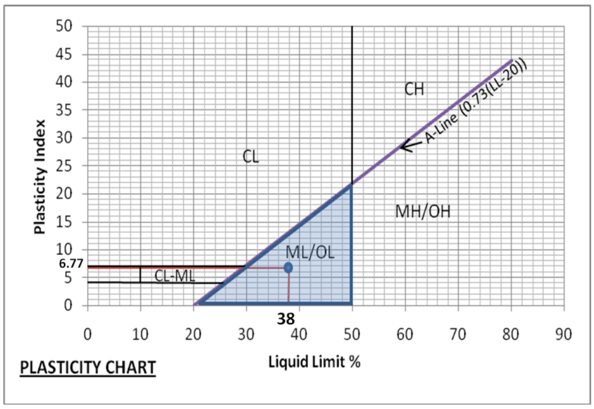

Chart – 2: Plasticity chart

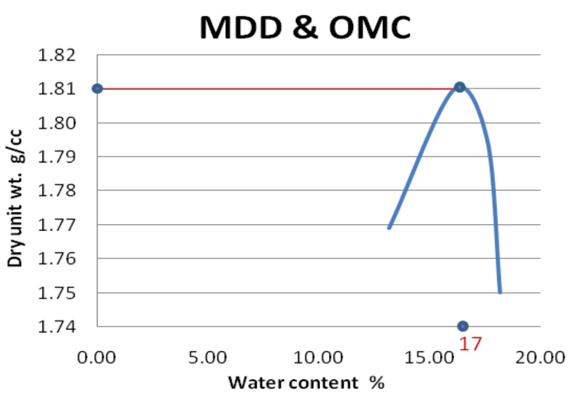

Chart – 3: Max dry density at opt moisture content

Table – 1: UCC test tabulation for preliminary soil

UNCONFINED COMPRESSION STRENGTH						
D_1	D_2	D_1 – Initial dia D_2 – Final dia H_1 – Initial height H_2 – Final height A_0 – C/S Area		H_1	H_2	A_0
38	38			82	74	1134.115
mm	mm			mm	mm	mm²
DEFORMATION		STRAIN	CORRECT AREA	PROVING RING		COMPRESSIVE STRENGTH
DIV	ΔL	$S=\Delta L/L_0$	$A_0/(1\text{-}S)$	DIV	Load	Load/Area
	mm		mm²		N	N/mm²
10	0.1	0.00122	1135.500	1	3.74	0.00329
20	0.2	0.00244	1136.888	2	7.48	0.00658
30	0.3	0.00366	1138.279	2	7.48	0.00657
40	0.4	0.00488	1139.674	6	22.44	0.01969
50	0.5	0.00610	1141.073	8	29.92	0.02622
60	0.6	0.00732	1142.475	10	37.4	0.03274
70	0.7	0.00854	1143.880	13	48.62	0.04250
80	0.8	0.00976	1145.288	16	59.84	0.05225
90	0.9	0.01098	1146.701	17	63.58	0.05545
100	1	0.01220	1148.116	17	63.58	0.05538
110	1.1	0.01341	1149.536	19	71.06	0.06182
120	1.2	0.01463	1150.958	19	71.06	0.06174
130	1.3	0.01585	1152.384	18	67.32	0.05842
$S = Cu = q_u/2$			0.03091			N/mm²

Chart – 1 shows liquid limit graph, we found the liquid limit value of study soil as 38%. Chart – 2 shows plasticity chart, we found the plastic limit value of study soil as 31.23% with plasticity index of 6.77 according to which the soil is silty soil of low plasticity. Chart – 3 shows compaction test reading of 1.81g/cc as max dry density at optimum moisture content of 17%. Table – 1, shows tabulation of UCC test conducted on study soil and the shear strength is found to be 0.03091 N/mm².

2.2 Effect on consistency limits of soil with addition of cement, fly ash, stone dust, rice husk

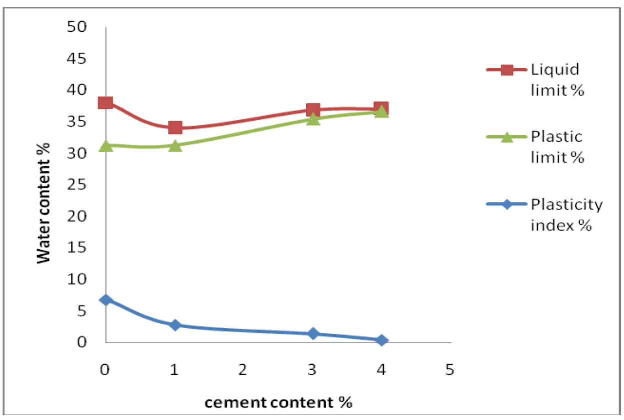

Chart – 4: Graph showing variation in Liquid limit, Plastic limit and Plasticity index for soil mixed with different proportions of Cement

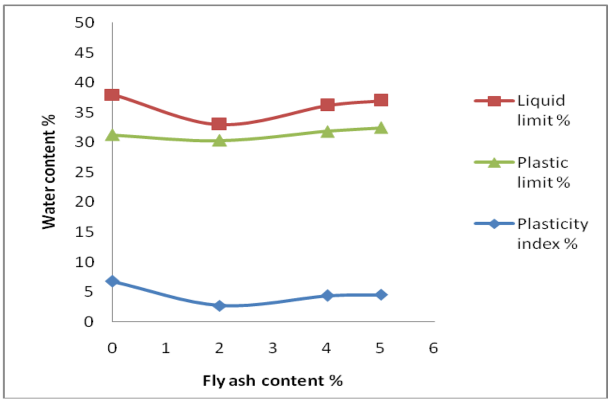

Chart – 5: Graph showing variation in Liquid limit, Plastic limit and Plasticity index for soil mixed with different proportions of Fly ash

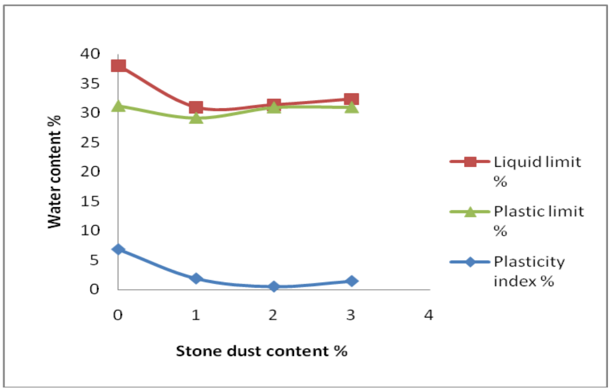

Chart – 6: Graph showing variation in Liquid limit, Plastic limit and Plasticity index for soil mixed with different proportions of Stone dust

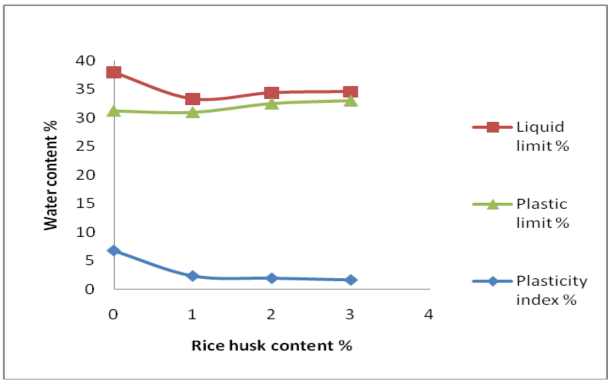

Chart – 7: Graph showing variation in Liquid limit, Plastic limit and Plasticity index for soil mixed with different proportions of Rice husk

The effect of stabilized soils on the liquid limit, plastic limit and plasticity index of the soil are shown in charts 4, 5, 6 and 7. It is observed that the plasticity index of stabilized soil decreases mainly due to an increase in plastic limit. In the present study the treated soil shows an increase in Liquid limit and Plastic limit values. Thus it observed that addition of various additives reduces plasticity of soil. Addition of 4% cement showed the least plasticity index value of 0.4.

2.3 Effect on compressive strength of soil with addition of cement, fly ash, stone dust, rice husk

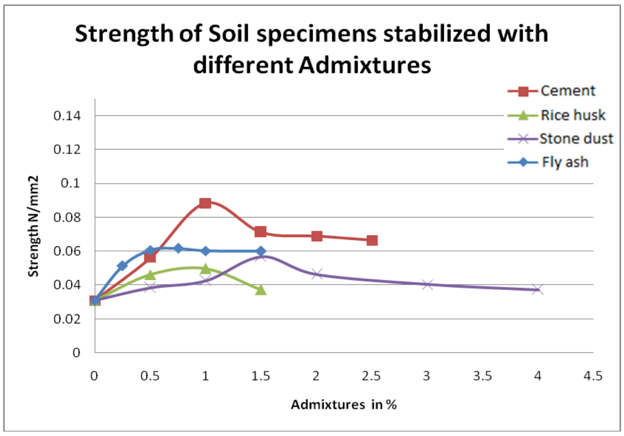

Chart – 8: Strength of soil stabilized with different admixtures (Soil-Fly ash, Soil-Cement specimens cured for 7 days)

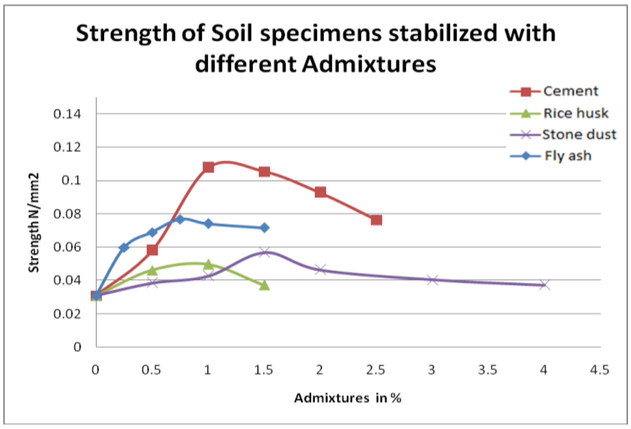

Chart – 9: Strength of soil stabilized with different admixtures (Soil-Fly ash, Soil-Cement specimens cured for 14 days)

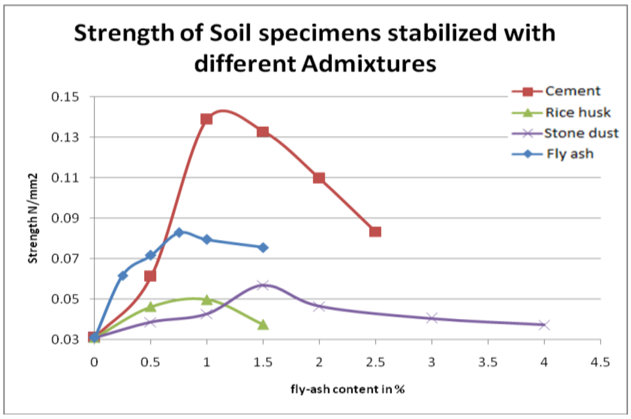

Chart – 10: Strength of soil stabilized with different admixtures (Soil-Fly ash, Soil-Cement specimens cured for 28 days)

Variation of strength of soil stabilized with admixtures in different proportions is shown in charts 8, 9 and 10. These graphs clearly show the increase in strength of cement and fly ash stabilized soil on curing them for a period of 7, 14 and 28 days.

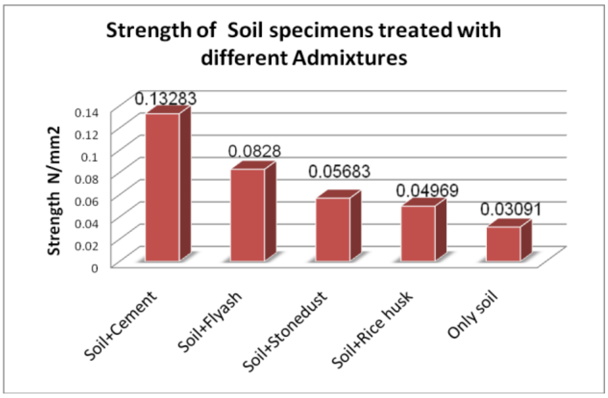

Chart – 11: Strength of soil stabilized with different admixtures

The effect of addition of various additives on the unconfined compressive strength of the soil is shown in chart 11. Cement shows undoubtedly a very effective additive to enhance the strength of tested soil. But as an artificial additive, fly ash showed 0.0828 N/mm^2 - strength at 0.75%, which is more than half of the strength of cement. Among the natural additives, stone dust proved to be more effective giving a compressive strength of 0.05683 N/mm^2 at an optimum content of 1.5%.

3. CONCLUSIONS

i. The admixtures are chosen from the origin of natural and artificial resources to use in soil for strengthening purpose.
ii. It is observed that the plasticity index of stabilized soil decreases mainly due to an increase in plastic limit.
iii. When the strength test were conducted on admixture stabilized soil such as cement, fly ash, stone dust and rice husk we found that the cement stabilized soil has 0.13283 N/mm^2 strength, fly ash has 0.0828 N/mm^2 strength, rice husk has 0.04969 N/mm^2 strength and stone dust has 0.05683 N/mm^2 strength.
iv. From the experimental values addition of cement to the silty soil by proportion of 1% will increase the strength of the soil by curing up to 28 days.
v. Fly ash is an abundantly available as waste material, used to strengthen this soil sample of Hebbal Lake is suitable as it shown strength value of 0.0828 N/mm^2 nearly as that of cement.
vi. In naturally available admixture stone dust is preferred over rice husk as it shows considerable increase in strength 0.04969 N/mm^2 to 0.05683 N/mm^2

ACKNOWLEDGEMENT

I am extremely grateful to Mrs. Lakshmi C, Associate Professor, for her guidance, co-operation and thankful to other staff members of SJBIT for their valuable support.

REFERENCES

[1] J. Prabakara etal, “Influence of fly ash on strength behaviour of typical soils”, Construction and Building Materials, vol. 18, 2004, pp. 263–267.
[2] Zalihe Nalbantoglu, “Effectiveness of Class C fly ash as an expansive soil stabilizer”, Construction and Building Materials, vol. 18, 2004, pp. 377–381.
[3] E.A. Basha etal, “Stabilization of residual soil with rice husk ash and cement”, Construction and Building Materials, 1 vol. 9, 2005, pp. 448–453.
[4] S. Kolias etal, “Stabilisation of clayey soils with high calcium fly ash and cement”, Cement & Concrete Composites, vol. 27, 2005, pp. 301–313.
[5] Gyanen etal, “Laboratory Study on Soil Stabilization Using Fly ash Mixtures”, International Journal of Engineering Science and Innovative Technology, vol. 2, issue. 1, Jan. 2013.
[6] Dr B.C. Punmia etal, Soil Mechanics and Foundations, Laxmi Publications.
[7] Dr P. Purushothama Raj, Ground Improvement Techniques, University Science Press.
[8] IS: 2720 (part 1) – 1977, Bureau of Indian Standards, New Delhi.
[9] IS: 2720 (part 5) – 1985, Bureau of Indian Standards, New Delhi.
[10] IS: 2720 Part 7 & 8, Bureau of Indian Standards, New Delhi.
[11] IS: 2720 Part 10, Bureau of Indian Standards, New Delhi.
[12] IS: 2720 (part 40) – 1977, Bureau of Indian Standards, New Delhi.