IJCSE International Journal of Computer Sciences and Engineering Open Access
Research Paper Volume-5, Special Issue-2, Dec 2017 E-ISSN: 2347-2693

A Comparative Analysis between Conventional and Non-Conventional Stabilizers

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Available online at: www.ijcseonline.org

Abstract - The main objectives of the soil stabilization are to increase the bearing capacity of the soil, weathering resistance and to enhance different properties of soil so as to make it more efficient. Unstable soils can create many problems such as in foundation and weak superstructure. Therefore it is necessary to stabilize the soil techniques to ensure the good stability and bearing capacity of soil and it can sustain more loads. According to times of India in our country 32000 million ton industrial waste is generated annually in which the ratio of fly ash and rice husk is 0.82%(265 million tons) and 0.41%(132 million tons) and out of that only 50 to 60% of these are utilized. Waste materials such Fly Ash, rice husk ash, pond ash may use to make the soil to be stable. Addition of such materials will increase the physical as well as chemical properties of the soil and also that is how we can more practically utilize these industrial wastes. Some properties which are expected to be improved are shear strength, unconfined compressive strength and bearing capacity etc. California bearing ratio (CBR) and other strength property tests were conducted on soil. By using waste material it reduces the cost of construction or we can say economical. The main problem with waste is their disposal so by using this we try to decrease their hazardous effect on environment. These materials show great results and can be useful in this sector as well also the results shows that they are not only the substitute of the conventional stabilizers but also they can be superior to them in some aspects.

Keywords – Rice husk ash, Fly Ash, Stabilization, Lime, cement

I. INTRODUCTION

As we all know soil plays a key role in stability of each kind of structure whether it's a pavement or a high rise skyscraper. All soils contain mineral particle, organic matter, water and air. The combination of these determines the various properties of soil like its texture, porosity, chemistry and load bearing capacity. Since each and every type of soil possess different kind of engineering properties but apparently the properties of soil differs place to place and sometime soil may deficient of some important properties and this kind of situation cause a costly remedial process for improving the engineering properties of the soil and thus making it more stable. It is required when the soil available for construction is not suitable for the anticipated purpose. In its broadest sense, stabilization includes compaction, pre-consolidation, drainage and many other such processes. However, the term stabilization restricted to the process which alter the soil material itself for improvement of its properties. A cementing Material or a chemical is needed to natural soil for the purpose of stabilization. Soil stabilization is used to decrease the permeability and compressibility of the soil mass in earth structures and to increase its shear strength. Soil stabilization is essential to increase the bearing capacity of foundation soils. However, the main use of stabilization is to improve the natural soils for the construction of highways and airfields. The principle of soil stabilization are used for controlling the grading of the soil and aggregates in the construction of bases and sub-bases of the highways and airfields. Different type of soil stabilization have been performed for thousands of years it wasn't too long after roads were developed that primitive engineers began looking for ways to improve the soil quality.

II. MATERIAL USED

1. Soil:- The soil which we are using is from the city Jaipur and there are mainly two type of soil
(a) Loamy soil: This is low in moisture content and has normal fertility and cover majority of the area.
(b) Sandy loam: This soil is semi-porous and fertile; it is generally yellowish brown with deep or light texture.

2. Cement
The cement we used is an ordinary port land cement of Ambuja brand's it of grade 53 Mpa.

3. Flyash
The fly ash we used is from Ashtech India power product which is a company situated in Jaipur.

4. Rice husk Ash
We took rice husk from the rice mills situated in Bundi, Rajasthan.

5. Lime
The lime we used is from the local supplier and has specific gravity of 2.34 and has pH level of 11.

6. Corn cob Ash
We took corn cob from the local shop and then convert into ash lately in the lab.

III. METHODOLOGY

A. Atterberg's Limit

This check is performed to determine the plastic and liquid limits of a fine grained soil. The liquid limit (LL) is arbitrarily defined as the water content, in percent, at which a part of soil in a standard cup and cut by a groove of standard dimensions will flow together at the base of the groove for a distance of 13 mm (1/2 in.) when subjected to 25 shocks from the cup being dropped 10 mm in a standard liquid limit apparatus operated at a rate of two shocks per second. The plastic limit (PL) is the water content, in percent, at which a soil can no longer be deformed by rolling into 3.2 mm (1/8 in.) diameter threads without crumbling.

B. Specific Gravity

The specific gravity of a soil is the ratio of the mass of a given volume of the material at a stated temperature to the mass of an equal volume of de-aired or gas-free distilled water at a declared temperature. The specific gravity of a soil is used in relating a weight of soil to its volume and in calculation of phase relationship, i.e. the relative volume of solids to water and air in a given volume soil and therefore The specific gravity is also used in the computations of most of the laboratory tests, and is needed in nearly all pressure, settlement, and stability problems in soil engineering.

Formulae used:

1. Ma (at T_X,) = density of water at T_X density of water at T_I x [M_a (at T_I) – M_f] + M_f

Where,

M_a = mass of Pycnometer and water, g

M_f = mass of Pycnometer, g

T_I = determined temperature of water, °C

T_X = any other desired temperature, °C

2. Specific Gravity, G at $T_X = M_o / [M_o + (M_a - M_b)]$

Where, M_o = mass of oven-dried specimen, g

M_a = mass of Pycnometer filled with water at temperature T_X, g, this value can be obtained from the table prepared under Section 5.2

M_b = mass of Pycnometer filled with water and soil at temperature T_X

T_X = temperature of the contents of the Pycnometer when the mass M_b was determined, °C

C. CBR (California Bearing Ratio)

This test method covers the determination of the California Bearing Ratio (CBR) of pavement subgrade, sub-base, and base/course materials from laboratory compacted specimens. The test method is primarily intended for but not limited to, evaluating the strength of cohesive materials having maximum particle sizes less than 19 mm (3 /4 in.).

D. Unconfined compression test

The purpose of this laboratory test is to determine the unconfined compressive strength of a cohesive soil sample. We will measure this with the unconfined compression test, which is an unconsolidated undrained (UU or Q-type) test where the lateral confining pressure is equal to zero (atmospheric pressure).

Formula used:

$$S = S_0 + (\varepsilon / 100) H_0$$

Where,

Measured initial height of sample (H_0),
The desired percent strain (ε)
The initial dial reading (S_0),
Dial readings (S)

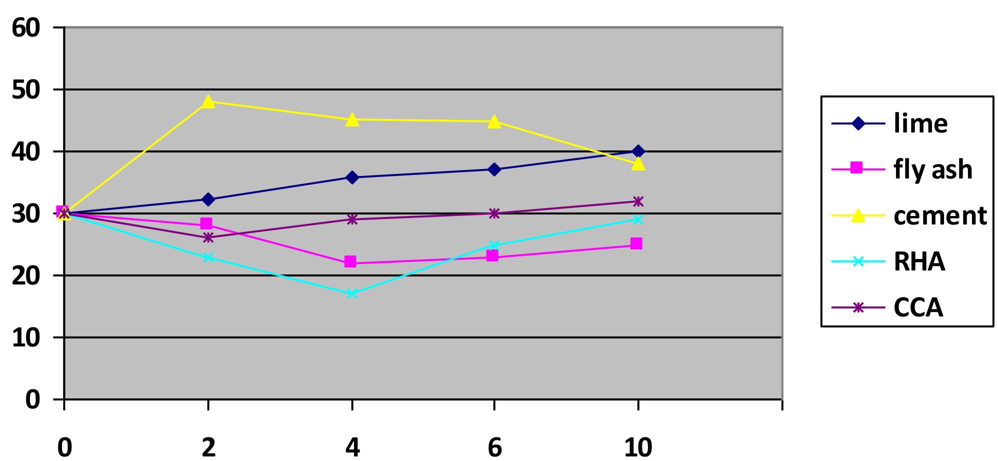
IV. Results

The values of considered properties of unstabilized and stabilized soil are analyzed in following sections to discuss the effectiveness of different stabilizing agents.

(i.) Effect of admixtures on liquid limit

% OF ADMIXTURE	LIME	FLY ASH	CEMENT	RHA	CCA
0	30	30	30	30	30
2	32.1	28	48	23	26
4	35.8	22	45.3	17	29
6	37.2	23	44.7	25	30
10	40	25	38	29	32

Table no. (i) – Variation in liquid limit



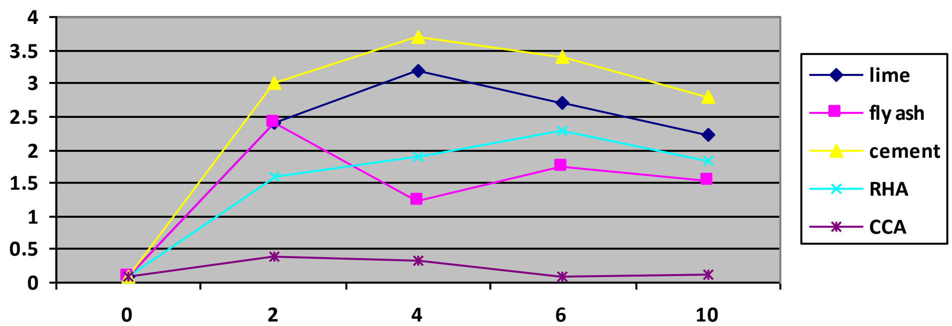
Graph (i)

Liquid limit of soil is 30 % and graph (i) shows the effect of admixtures on soil stabilization here when we add lime the liquid limit of the soil gradually increase and reach up to 40% and in case of cement it first increases then decreases from 48% to 38% while in case of non-conventional stabilizer Flyash and rice husk ash (RHA).

(ii) Effect of admixtures on plastic limit

% OF ADMIXTURE	LIME	FLY ASH	CEMENT	RHA	CCA
0	0.1	0.1	0.1	0.1	0.1
2	2.4	2.4	3	1.6	0.4
4	3.2	1.23	3.7	1.9	0.32
6	2.7	1.75	3.4	2.3	0.1
10	2.23	1.52	2.8	1.83	0.11

Table No. (ii) – variation in plastic limit



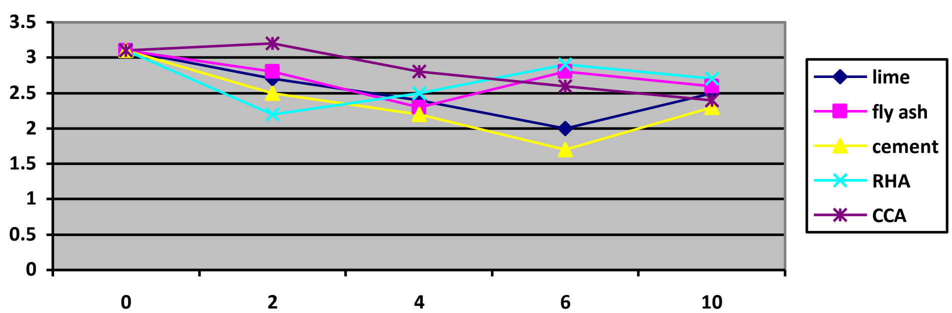
Graph (ii)

Plasticity of a soil is a property which shows the presence of the clay in it the soil which we've took has plasticity of 1%. After addition of conventional stabilizer it increase instantly but then decreases while in case of non-conventional stabilizers it does not go that much high and then decreases gradually.

(iii) Effect of admixture on specific gravity

% OF ADMIXTURE	**LIME**	**FLY ASH**	**CEMENT**	**RHA**	**CCA**
0	3.1	3.1	3.1	3.1	3.1
2	2.7	2.8	2.5	2.2	3.2
4	2.4	2.3	2.2	2.5	2.8
6	2	2.8	1.7	2.9	2.6
10	2.5	2.6	2.3	2.7	2.4

Table No. (iii)



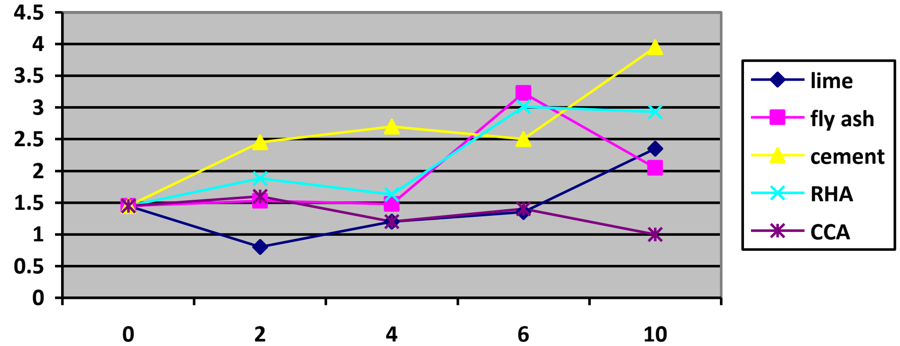
Graph (iii) – variation in specific gravity

The specific gravity of the soil is 3.1 but when we add conventional admixtures in it goes down at first up to 1.6 then it rises again up to 2.6

(iv.) Effect of admixtures on CBR values

% OF ADMIXTURE	LIME	FLY ASH	CEMENT	RHA	CCA
0	1.45	1.45	1.45	1.45	1.45
2	0.8	1.53	2.45	1.88	1.6
4	1.2	1.48	2.7	1.63	1.2
6	1.35	3.23	2.5	3.01	1.4
10	2.35	2.05	3.95	2.93	1

Table No. (iv) – variation in CBR values



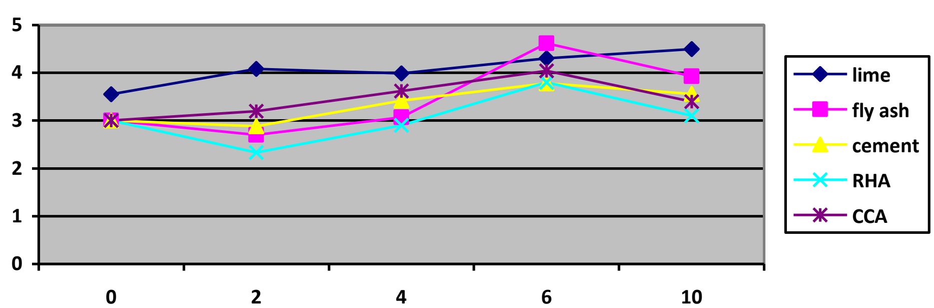
Graph (iv)

CBR value of the soil is 1.45 but after the addition of cement and lime it increase very fast as they both are binding materials but in the long term they can affect the structure of the soil and can create cracks which may leads to soil failure eventually but the non-conventional stabilizers like fly ash and rice husk ash are effective as well as safe.

(v.) Effect of admixtures on unconfined compression test

% OF ADMIXTURE	LIME	FLY ASH	CEMENT	RHA	CCA
0	3.55	3	3	3	3
2	4.08	2.7	2.88	2.33	3.2
4	3.99	3.07	3.42	2.9	3.62
6	4.3	4.62	3.78	3.8	4.04
10	4.5	3.93	3.56	3.1	3.4

Table No. (v) – variation in UCC values



Graph (v)

V. Conclusion

1. First of all We can conclude that the efficiency of the conventional and non-conventional stabilizers are nearly the same the non-conventional stabilizers also gives the same amount of stabilization to the soil and with that they are quite ecofriendly and economic.

2. All the non-conventional stabilizers we are using are processed industrial waste. So use of these admixtures as soil stabilizers can be more helpful in the disposal of them. Also test results shows that they do not rapidly react with the soil instead of that they gradually increase the desirable properties without doing some chemical reaction to the soil which lately affects the quality of the soil.

3. Test results suggest that the Rice husk Ash (RHA) has better future possibilities as soil stabilizers since it is directly derived from a highly consumable crop so its availability is also not affected in future.

4. It can also be concluded that the improved CBR value and decrease in plasticity is due to addition of lime and cement as an admixture. In this type of soil i.e. loamy soil, new material is used i.e. corn cob ash which reduces the plasticity but not workable for improvement of other properties as compared to conventional stabilizers.

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