IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 12, Issue 4 Ver. VI (Jul. - Aug. 2015), PP 33-36
www.iosrjournals.org

Stabilization of Low Shear Strength Soil by using Fly Ash

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Abstract: *Many infrastructure projects such as highways, railways, water reservoirs, reclamation etc. requires huge earth material. In such a way to enhance the engineering properties of the soil, it requires various soil stabilization techniques. Soil stabilization is used very widely for the construction of road pavement and foundation construction, to enhance engineering properties such as strength volume stability and durability.*

Soil is a peculiar material some waste materials such as Fly Ash, rice husk ash, pond ash may used to make the soil stable. And to addition of such materials will increase the physical properties of it. Fly Ash generated by the combustion of coal for energy production. It is an industrial by product. It may be of types C and F. In the present investigation is to evaluate the compaction and unconfined compressive strength of cohesive soil by using Fly Ash Mixtures. Some expecting properties to be improved such as shear strength of soil by the mixing of Fly Ash on different varying percentage of Fly Ash. It was found that the maximum shear strength is increased by 4 percent when 10 percent of fly ash by weight is mixed in soil and no remarkable change in internal friction.

Keywords: *Stabilization of Soil, Fly Ash, Types of Soil, Triaxial Shear Test*

I. Introduction

Soil stabilization is a technique used to increase the stability of soil mass. The aim of this test or experiments is to stabilize the locally available clayey soil. Clayey soils usually have the undesirable engineering properties or behaviour such as low bearing capacity, high shrinkage and swell characteristics. Fly Ash produced every year in large amounts of coal is burned in coal –Fired Power Plants. This creates a serious problem in terms of create a land fill for it and environmental pollution. Fly Ash has its major two types class C and class F. the property of Fly Ash depends on the type of coal. Class C Fly Ash is generally obtained by burning sub bituminous or lignite coal and class F is produced by burning anthracite in bituminous coal. The soil stabilization is done for the some specific reason: soil stabilization is widely used in connection with foundation construction, pavement and road. It increases the bearing capacity of soil, to control the swell shrink characteristics caused by moisture changes in soil, to increase the resistance to erosion, weathering or traffic loading and reduce the pavement thickness as well as cost of soil stabilization.

II. Literature Review

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.

Erdal Cokca (2001): Effect of Fly ash on expansive soil was studied by Erdal Cokca, Fly ash consists of often hollow spheres of silicon, aluminum and iron oxides and unoxidized carbon. There are two major classes of fly ash, class C and class F. The former is produced from burning anthracite or bituminous coal and the latter is produced from burning lignite and sub bituminous coal. Both the classes of fly ash are puzzolans, which are defined as siliceous and aluminous materials. Thus Fly ash can provide an array of divalent and trivalent cations (Ca_2+,Al_3+,Fe_3+etc) under ionized conditions that can promote flocculation of dispersed clay particles. Thus expansive soils can be potentially stabilized effectively by cation exchange using fly ash. He carried out investigations using Soma Fly ash and Tuncbilek fly ash and added it to expansive soil at 0-25%. Specimens with fly ash were cured for 7days and 28 days after which they were subjected to Odometer free swell tests. And his experimental findings confirmed that the plasticity index, activity and swelling potential of the samples decreased with increasing percent stabilizer and curing time and the optimum content of fly ash in decreasing the swell potential was found to be 20%. The changes in the physical properties and swelling potential is a result of additional silt size particles to some extent and due to chemical reactions that cause immediate flocculation of clay particles and the time dependent puzzolonic and self hardening properties of fly ash and he concluded that both high –calcium and low calcium class C fly ashes can be recommended as effective stabilizing agents for improvement for improvement of expansive soils.

Pandian et.al. (2002). Studied the effect of two types of fly ashes Raichur fly ash (Class F) and Neyveli fly ash (Class C) on the CBR characteristics of the black cotton soil. The fly ash content was increased from 0 to 100%. Generally the CBR/strength is contributed by its cohesion and friction. The CBR of BC soil, which consists of predominantly of finer particles, is contributed by cohesion. The CBR of fly ash, which consists predominantly of coarser particles, is contributed by its frictional component. The low CBR of BC soil is attributed to the inherent low strength, which is due to the dominance of clay fraction. The addition of fly ash to BC soil increases the CBR of the mix up to the first optimum level due to the frictional resistance from fly ash in addition to the cohesion from BC soil. Further addition of fly ash beyond the optimum level causes a decrease up to 60% and then up to the second optimum level there is an increase. Thus the variation of CBR of fly ash-BC soil mixes can be attributed to the relative contribution of frictional or cohesive resistance from fly ash or BC soil, respectively. In Neyveli fly ash also there is an increase of strength with the increase in the fly ash content, here there will be additional puzzolonic reaction forming cementitious compounds resulting in good binding between BC soil and fly ash particles

Phanikumar and Sharma (2004): A similar study was carried out by Phanikumar and Sharma and the effect of fly ash on engineering properties of expansive soil through an experimental programme. The effect on parameters like free swell index (FSI), swell potential, swelling pressure, plasticity, compaction, strength and hydraulic conductivity of expansive soil was studied. The ash blended expansive soil with fly ash contents of 0, 5, 10, 15 and 20% on a dry weight basis and they inferred that increase in fly ash content reduces plasticity characteristics and the FSI was reduced by about 50% by the addition of 20% fly ash. The hydraulic conductivity of expansive soils mixed with fly ash decreases with an increase in fly ash content, due to the increase in maximum dry unit weight with an increase in fly ash content. When the flash content increases there is a decrease in the optimum moisture content and the maximum dry unit weight increases. The effect of fly ash is akin to the increased compactive effort. Hence the expansive soil is rendered more stable. The undrained shear strength of the expansive soil blended with fly ash increases with the increase in the ash content.

III. Classification Of Soil

As per IS: 1498-1970. Soils are divided in three parts:

- Coarse grain soil is that in which more than half of the total material by weight is larger than 75m micron is sieve size.
- Fine grained soil is that in which more than half of the total material by weight is smaller than 75 micron is sieve size.
- Highly organic soil and other miscellaneous soil materials.

IV. Methods Involved

The following Laboratory tests were carried out- as per IS: 1498-1970 classification of soil and IS 2720. The tests were carried out on both normal soil and stabilized soil.

- Classification of soil as per IS:1498:1970
- Specific gravity test
- Grain size Analysis
- Atterbergs limits
- Proctor compaction test
- Triaxial compression test for compressive strength

V. Experimental Setup

(A) Unconfined Compressive Tests

- All the unconfined compressive test was conducted in accordance with the standard IS: 2720 (part 10)-1973.
- The load per unit area at which on unconfined cylindrical specimen of soil will fail in a simple compression test. Test specimen shells have a minimum diameter of 38mm and the height to diameter ratio of 2 and the largest particle contained should be smaller than $1/8^{th}$ of the specimen diameter.

(B)Triaxial Shear Test

- IS:2720 (part11)-1971 a cylindrical specimen of soil encased in an impervious membrane is subjected to a constant confining pressure and then loaded axially@1.25mm per minute to failure without change in total water content in the specimen.
- The standard prescribed the use of an apparatus with a maximum load capacity of 1KN to 2.5KN. The test is limited to specimen in the form of the right cylinder of Nominal diameter 38mm and height equal to

twice the Nominal diameter. The ratio of diameter of the specimen to maximum size of particles in the soil should not be less than 5.

VI. Experimental setup and results

Table I: Indicating Test Results

S. No	Type of sample	Sieve Analysis Passing Percentage By Weight				Atterbergs Limits			IS Group	Proctor Test		Specific Gravity	Shear Characteristic		Type of Test
		4.75 mm	2.00 mm	0.425 mm	0.075 mm	LL %	PL %	PI %		OMC %	MDD gm/cc		Cohesion kg/cm (C)	Angle of Internal Friction (ø)	
1	D.S.	100	100	99	91	34	17	17	CL	14.0	1.85	2.68	0.81	26°	UU

Table II: Indicating Test Result Proctor Test

Sl. No	Type of sample	Proctor Test	
		OMC %	MDD gm/cc
1	Fly Ash	16.0	1.08

Table III: Indicating Test Results Of Proctor Test and Triaxial Test of Soil Samples

S. No	Description Of Sample	Proctor Test		Shear Characteristic		Type of Test
		OMC %	MDD gm/cc	Cohesion kg/cm (C)	Angle of Internal Friction (ø)	
1	Soil+5%Fly Ash	15.0	1.80	0.80	28°	UU
2	Soil+10%Fly Ash	15.2	1.75	0.90	25°	UU
3	Soil+20%Fly Ash	15.0	1.69	0.75	27°	UU
4	Soil+30%Fly Ash	15.0	1.64	0.60	29°	UU

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Figure 1: Experimental Setup with Object

Figure 2: Experimental Analysis at Setup

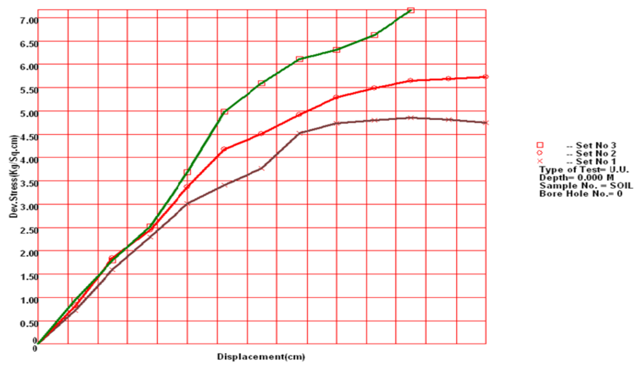

Figure 3: Soil Graph

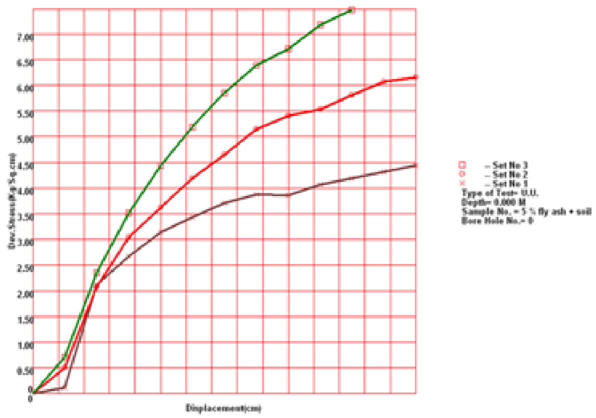

Figure 4: Soil + 5% Fly Ash Graph

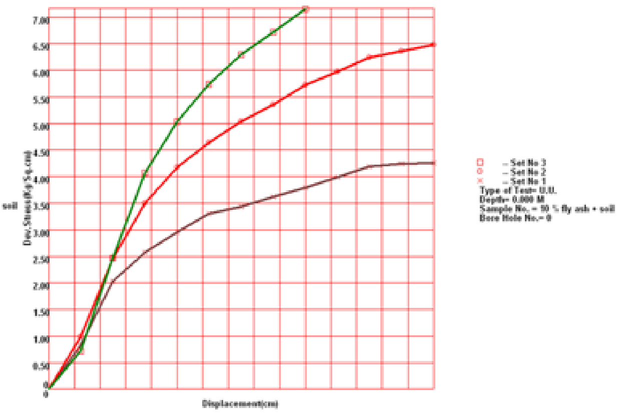

Figure 5: Soil + 10% Fly Ash Graph

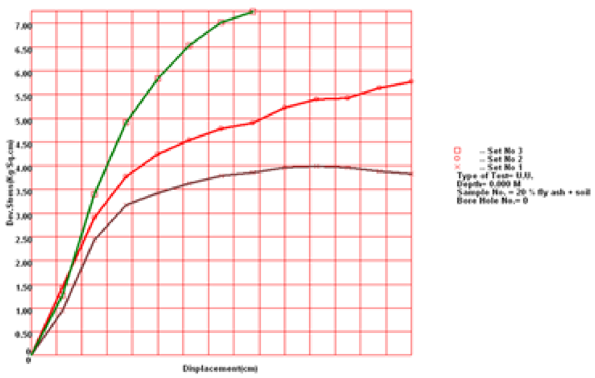

Figure 6: Soil + 20% Fly Ash Graph

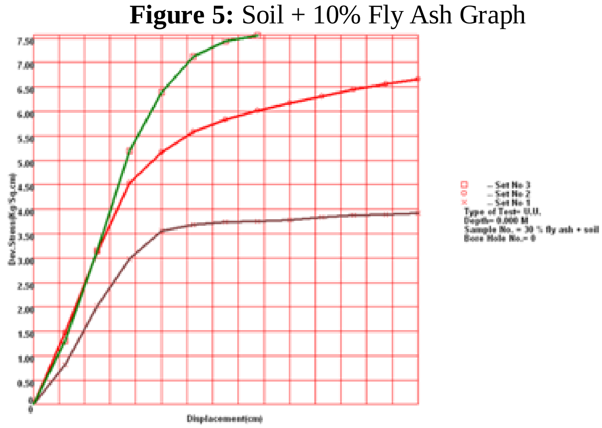

Figure 7: Soil + 30% Fly Ash Graph

VII. Conclusion

It is observed that the generation of the Fly Ash is more than its utilization. Moreover, the conventional material in the construction gives desired result as the experiment shows in the above graph. Thus we found that the Fly Ash is not only cost effective but also improved the characteristics of soil to make more stable slopes. It improves the characteristics of both granular and cohesive soil for the actual practice more and more laboratory studies are required to understand long term behaviour of expansive soils treated with Fly Ash and study their engineering properties.

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