International Journal of Civil and Structural Engineering Research ISSN 2348-7607 (Online)
Vol. 2, Issue 2, pp: (118-123), Month: October 2014 - March 2015, Available at: www.researchpublish.com

Stabilization of Diesel Oil Contaminated Soil Using Fly Ash

Dr. Solly George[1], Aswathy EA[2], Berlin Sabu[3], Krishnaprabha NP[4], Maria George[5]

[1]Professor , [2, 3, 4, 5]Under Graduate students
[1, 2,3,4,5] Mar Athanasius College of Engineering, Kothamangalam, India

Abstract: **The utilization of industrial bi-products such as fly ash is of increasing importance as an option for stabilizing contaminated sites due to its pozzolanic nature and also in view of minimising the environmental impact. The experimental programme was carried out in the present study to know the efficacy of fly ash as stabilizing agent at different percentages 20%, 40% and 60% (w/w) on the geotechnical properties of diesel Contaminated Soil (CS). The soil considered in the present work was locally available sandy soil and the common petroleum hydrocarbon diesel engine oil was selected as contaminant. Laboratory studies were conducted on uncontaminated (VS) and soil contaminated to degree of contamination (12% expressed as a dry weight of soil v/w) to compare the geotechnical characteristics before and after contamination. The results show that the consistency limits are affected marginally due to contamination. The compaction characteristics of stabilized soils were observed to be not uniform with increase in fly ash addition. The CBR value of the soil decreased with addition of contaminant and it regain marginally with addition of fly ash.**

Keywords: **Contaminated soil, Fly ash, Pozzolanic nature, Stabilization.**

I. INTRODUCTION

Soil contamination is caused by manmade chemicals such as oil, heavy metals, organic pollutants and alterations in the natural soil environment. Contamination changes the behaviour of soil and also alters its engineering properties which leads to several problems like loss in strength, differential settlement, and cracks in existing foundation or structure. High concentration of chemicals and toxic metals made the soil incapable for any intended engineering works. Oil contaminated soils result from leaking underground storage tanks, or oil spills from surrounding petroleum refineries or crude oil wells. Waste materials like fly ash whose disposal consuming a lot of land and money are very useful to stabilize the contaminated soil. Considering these issues related to soil contamination the present study focused on stabilisation of diesel engine oil contaminated soils with fly ash.

II. MATERIALS AND METHODOLOGY

A. Soil:

The soil sample was collected from the premises of Mar Athanasius College of Engineering, Kothamangalam. Particle size analysis showed that the sample consisted of 60%sand, 32% silt and clay. The proportions of gravel and sand in soil samples showed high % of sand and moderate amount of silt proportion.

TABLE I: Geotechnical properties of soil.

Properties	Value
Particle size	
Gravel (%)	8
Coarse sand (%)	16
Medium sand (%)	28
Fine sand (%)	16
Clay + Silt (%)	32

Consistency limits	
Liquid limit (%)	33.2
Plastic limit (%)	30.57
Shrinkage limit (%)	21.24
Specific gravity	2.67
Compaction characteristics	
Max. dry density	1.73g/cc
OMC (%)	17.5
Strength characteristics	
Unconfined compressive strength	14.7kN/m^2
CBR value	10.7

B. Diesel oil:

Diesel oil was used to contaminate the soil.

C. Fly ash:

To stabilize the contaminated soil, fly ash was used and it is classified as class F fly ash according to its chemical composition. The property of fly ash is listed in the Table II.

TABLE II: Properties of Fly Ash.

	CHARACTERISTICS	RESULT
A	**CHEMICAL PROPERTIES**	
1	SiO_2 +Al_2O_3 + Fe_2O_3	92.65
2	SiO_2	63.22
3	MgO	0.58
4	SO_3	0.74
5	Na_2O	0.68
6	Total chlorides	0.007
7	Loss on ignition	0.88
B	**PHYSICAL PROPERTIES**	
1	Fineness- specific surface in m^2/kg	360
2	Particles retained on 45 microns	32.84

D. Sample preparation:

The various operations involved in this study consist of evaluation of geotechnical properties of soil contaminated with 4%, 8% and 12% diesel oil and stabilization of 12% contaminated soil, which showed the worst behaviour with 20%, 40% and 60% fly ash.

III. RESULTS AND DISCUSSIONS

A. Atterberg limits:

Atterberg limits were determined as per IS: 2720 (PART V). Figure 1, 2, 3 shows the variation of consistency limits with 12% contaminated and stabilized soils with 20%, 40%, 60% fly ash.

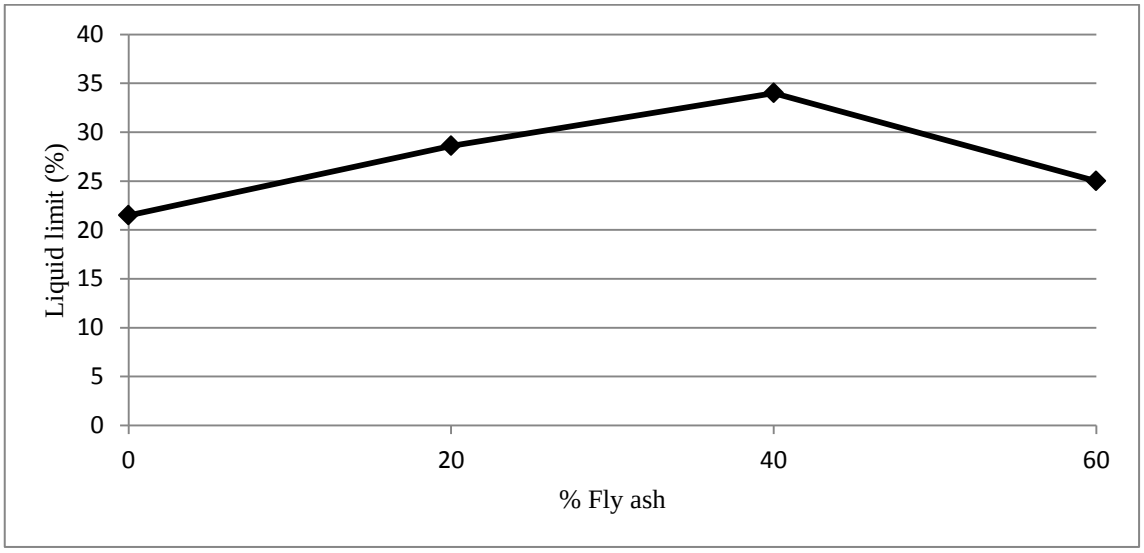

Fig.1. Liquid limit variations for stabilized soil.

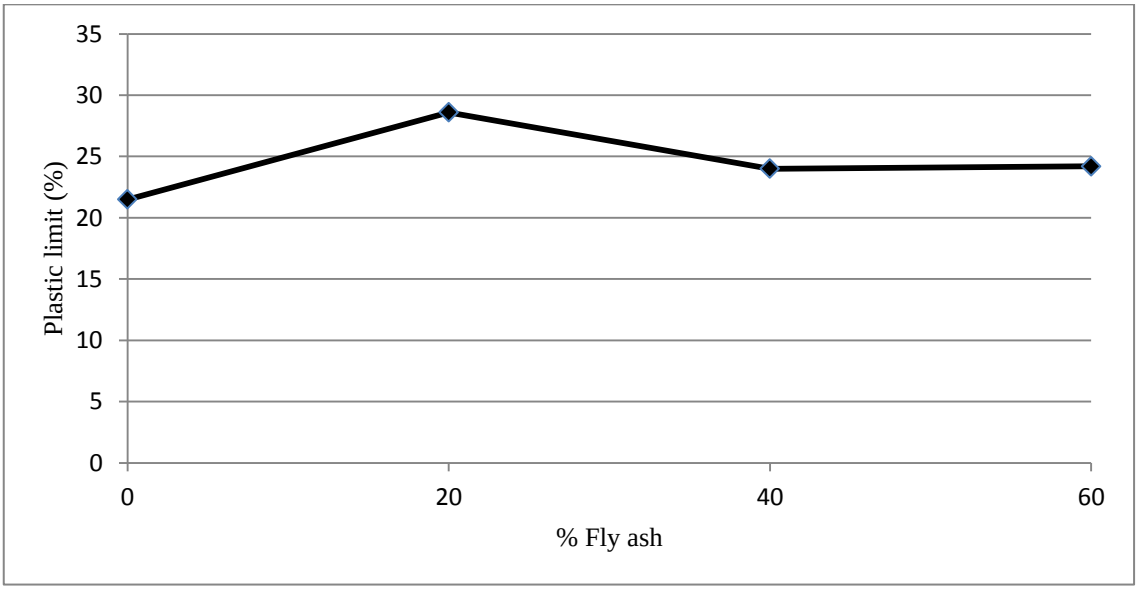

Fig.2. Plastic limit variations for stabilized soil.

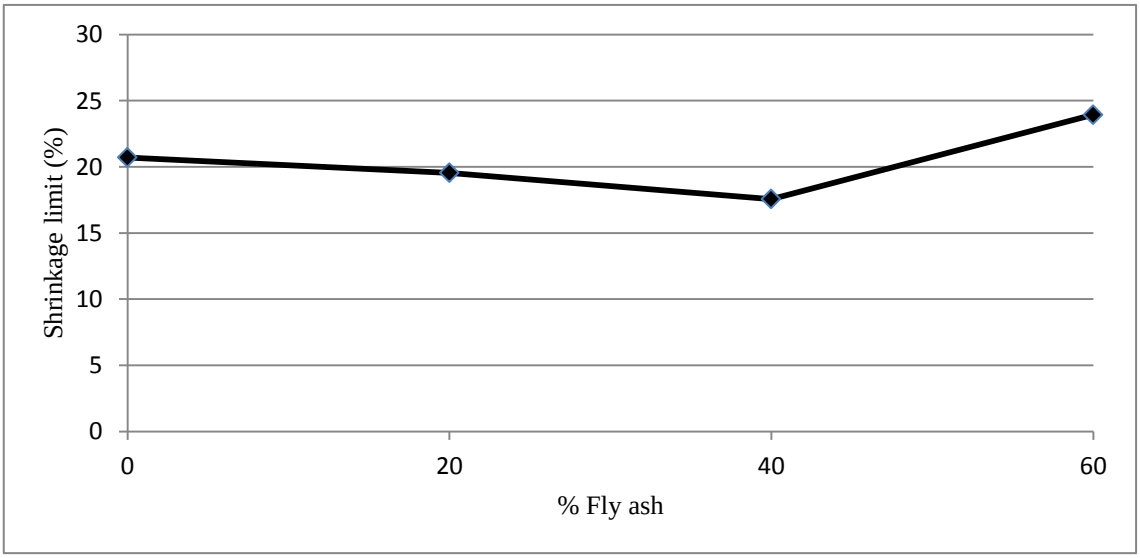

Fig.3.Shrinkage limit variations for stabilized soil.

B. Compaction characteristics:

Compaction test confirming IS: 2720 (Part VII) were carried out on contaminated soil and stabilized soils with 20%, 40% and 60% fly ash. The MDD and OMC of contaminated soil slightly decreased and increased respectively. It has also observed that compaction process of contaminated soil has become tougher as water content increases. Stabilization with higher percentage of fly ash (greater than 20%) minimized this problem. The compaction properties of fly ash added soils are uniform. The values of OMC and MDD are decreased in comparison to uncontaminated soil. Maximum dry density variations for 12% contaminated soil samples with different percentages of fly ash is shown in Fig.4.

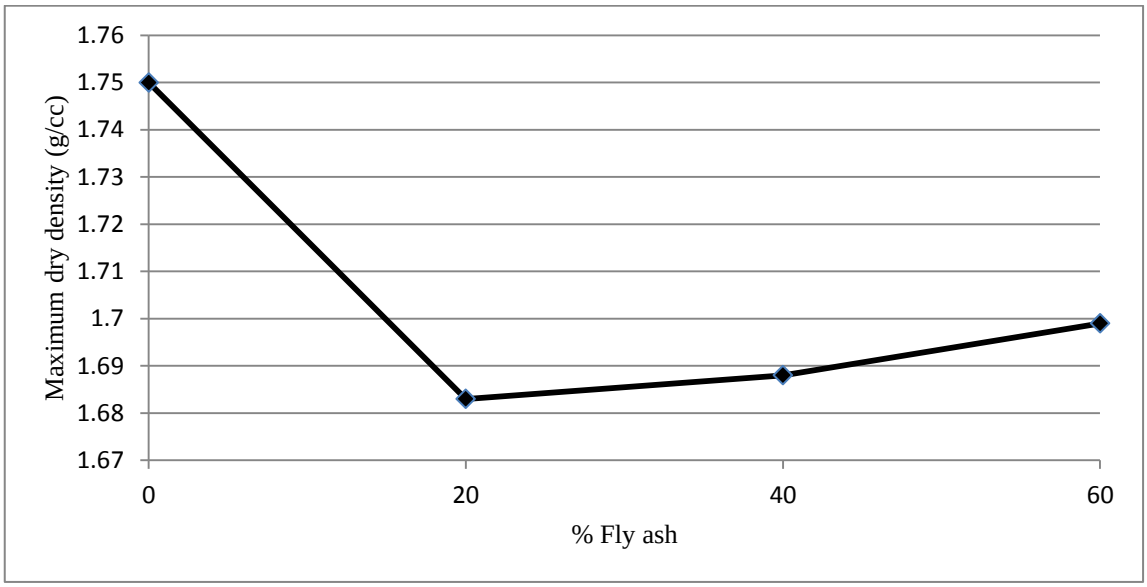

Fig.4. Maximum dry density variations for stabilized soil.

C. Unconfined compressive strength:

Unconfined compressive strength test (confirming IS: 2720 (PART X) results show that the UCS is decreased when soil is stabilized with fly ash. Figure 5 shows the variation of strength of 12% contaminated soil samples with different percentages of fly ash.

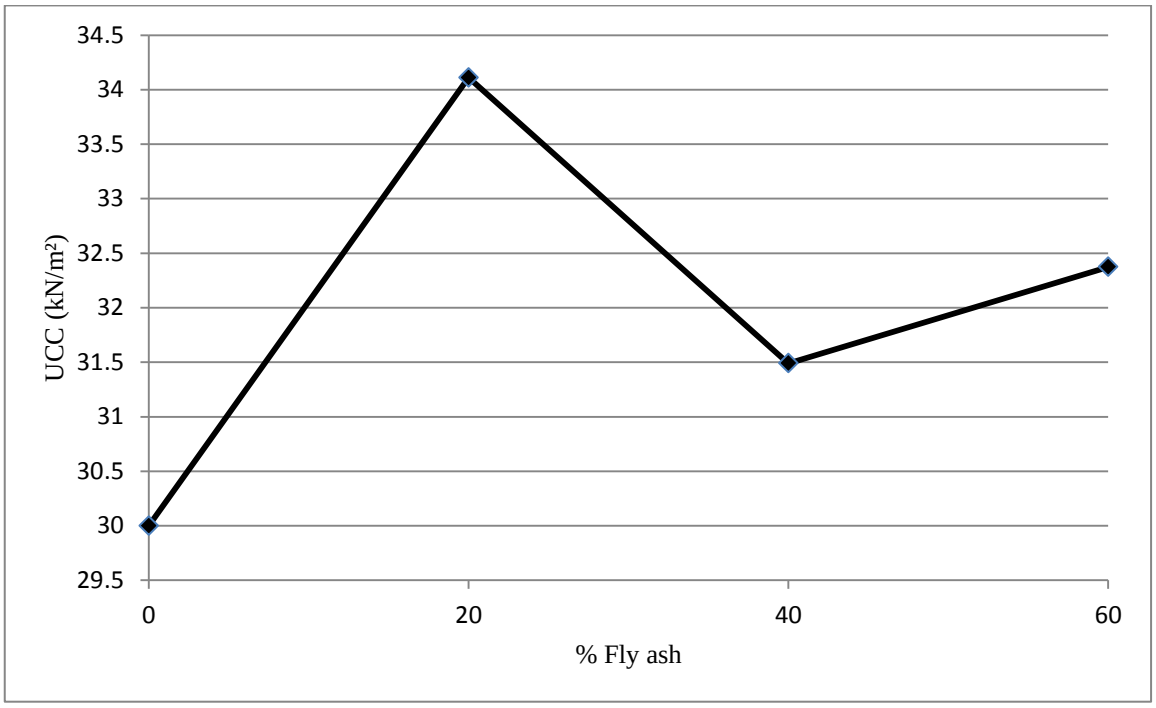

Fig.5.Strength variations for stabilized soil.

D. California Bearing Ratio test results:

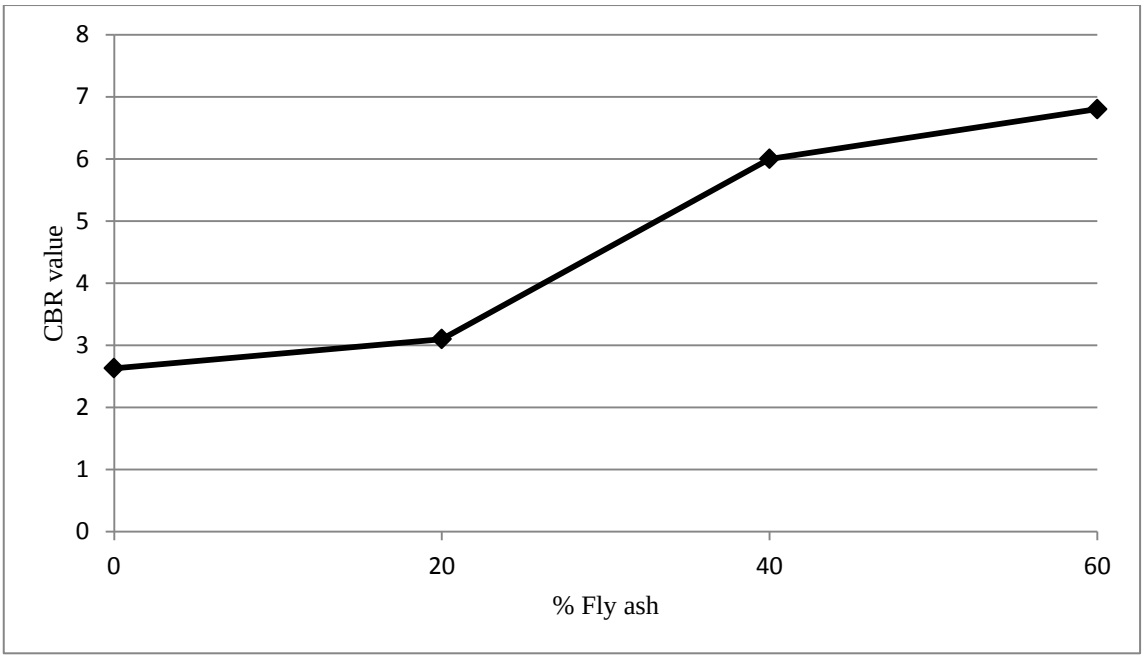

Fig.N. CBR value variations for stabilized soil.

Fig.N shows the variation of un soaked California bearing ratio with percentage of fly ash in the contaminated soil. The un soaked CBR value increases from 2.63% to 6.8% as the percentage of fly ash increases from 0 to 60%.

E. Influence of fly ash on soil properties:

SOIL	PROPERTIES					
	Liquid limit (%)	**Plastic limit (%)**	**Shrinkage limit (%)**	**Maximum Dry density**	**CBR value**	**UCC (kN/m²)**
Contaminated	23	21.5	20.71	1.75	2.63	30
Contaminated + 20 % Fly ash	32.3	28.6	19.55	1.683	3.1	34.11
Contaminated + 40 % Fly ash	34	24	17.565	1.688	6	31.49
Contaminated + 60 % Fly ash	25	24.2	23.93	1.699	6.8	32.373

IV. CONCLUSIONS

The study demonstrates the stabilization of local soil contaminated by 12% diesel and its influence on geotechnical characteristics.

- By addition of fly ash CBR value of the contaminated soil increased from 2.63 to 6.8.
- The maximum dry density of the contaminated soil samples was found to be increasing at higher percentages of fly ash.

The stabilization of contaminated soil by fly ash improved the soil characteristics to some extent. It is apparent from the test results that the stabilization agents improved the geotechnical properties of the soil by way of cation exchange, agglomeration, and pozzolanic actions. From the overall observations of the study that, the stabilization of diesel engine oil contaminated soil using fly ash has been observed to be effective.

REFERENCES

[1] Gupta, M.K., Srivastava, R.K.,(2010), "Evaluation of Engineering Properties of Oil-contaminated Soils", Journal of the Institution of Engineer India. Civil engineering 90, 37-42.

[2] Khamehchiyan M., Charkhabi A.H. and Tajik M. (2007). "Effects of Crude Oil Contamination on Geotechnical Properties of Clayey and Sandy Soils", Engg. Geology, 89: 220–229.

[3] Shah,S.J., Shroff, A. V.,Patel, J.V., Tiwari,K.C. and Ramakrishan,D.(2003), "Stabilization of fuel oil contaminated soil - A Case Study", Geotechnical and Geological Engineering, 21,, 415–427.

[4] Habib-Ur-Rehman, Sahel N. Abduljauwad and Tayyeb Akram (2007). "Geotechnical Behavior of Oil-Contaminated Fine-Grained Soils", E. Jl. Geotech. Engg, 0720.

[5] Blight, G.E. 1997. Mechanics of Residual Soils: A guide to the formation, classification and geotechnical properties of residual soils, with advice for geotechnical design. Rotterdam, The Netherland: Balkema Publishers.

[6] Rahman,Z.A., U.Hamazah, M.R.Taha ,N.S.Ithnain and Ahmad,2010."Influence of oil contamination on Geotechnical Properties of Basaltic soil."Am.J.applied sci.,&:7

[7] IS 2720: Part X: (1973). "Determination of Unconfined Compressive Strength", Bureau of Indian Standards, New Delhi, India.

[8] Sivapullaiah P.V. and Manju (2006). "Ferric Chloride Treatment to Control Alkali Induced Heave in Weathered Red Earth", Geotechnical and Geological Engineering, 24: 1115–1130.

[9] Phanikumar B.R. and Sharma R.S. (2007). "Volume Change Behaviour of Fly Ash Stabilized Clays", Jl. Materials in Civil Engg, 19(1): 67–74.