International Journal of Geological and Geotechnical Engineering
Vol. 1: Issue 1
www.journalspub.com

Stabilization of Red soil by Using Boiler Feed Ash

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Abstract

Red soil is the one of the irrigation soil. Most of plants are grown in this soil. The red soil has the most iron content when compared to other soils and it has also got various chemical properties. The red soil has less bearing strength and more water permeability. By the addition of fly ash and BFA to the red soil the liquid limit, plastic limit and bearing strength can be increased. The fly ash is maintained on 10% and the precipitated silica is added from 10% to 50% by replacement of soil. The soil character is changed on the addition of admixtures.

Keywords: *Soil stabilization, red soil, compaction, OMC, CBR*

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INTRODUCTION

Red earth soil is a non-expansive soil having kaolinite as key clay mineral and it is natural soil available in vast areas of India and especially in Karnataka. Mine tailings is an industrial by-product which is produced in huge quantity from mining industries after extraction of minerals from pyretic ores and poses critical disposal problems. It also leads to environmental hazard. Recently, there is an increase in trend to utilize the mine tailings for geotechnical applications, provided they are treated with some admixtures. Hence, an attempt has been made in the present study to utilize the mine tailings for geotechnical applications with the addition of some stabilizing agents. Stabilization is found to be one of the effective methods to improve the engineering properties of soils[1].

The increasing demand for electrical power to the rapidly growing industrial as well as agricultural sectors has resulted in the setting up of a number of coal-based thermal power stations in India. Large quantities of fly ash are being produced from these thermal power stations. The disposal of ash leads to environmental pollution and disposal problem. To avoid these problems, many novel methods are being explored for its utilization in many fields, especially in geotechnical engineering applications[2].

Stabilization of soils with low-bearing capacity is a cost-effective way to strengthen the earth for construction purposes. Engineers often face the problem of constructing facilities on or with soils, which do not have satisfactory strength to support the loads imposed upon them either during construction or during the service life of the structure. Geiman (2005) used a set of traditional and non-traditional stabilizers[3]. BEA and fly ash have caused problems either during construction or resulted in poor performance in service. In their investigation, they selected four different types of SC soils and attained substantial increase in CBR value (to 20% with 2% stabilizer).The rate of increase in compressive strength of stabilized soil samples (after 7 days curing) with

increasing stabilizer content was not significant. Hence, it was concluded that low percentages about 10–60% of stabilizer is effective to improve the properties of such clayey soils. The study also revealed that both unsoaked and soaked CBR increase significantly with the addition of BFA, fly ash red soil and lateritic soil. Bhuyan (2010) conducted a study using industrial wastes blast furnace slag (BFS) and fly ash[4]. Strength, bearing capacity, volume stability and durability were increased by the method of stabilization using lime and proprietary cementitious stabilizer[5].

MATERIALS USED

1. Red soil
2. Fly ash
3. Precipitated silica

RESULT AND DISCUSSIONS

Atterberg's Limit

The Atterberg's limit of native soil and the soil-RBI 81 mixtures have been performed in accordance to IS 2720: Part 5. The results are summarized in Table 2. The tests indicated a marginal increase in plastic limit and liquid limit which resulted in marginal reduction in plasticity index indicating a significant improvement in soil.

Table 1: *Index and Strength Property of Red Soil.*

Liquid limit	23.37
Plastic limit	28.21
Plasticity index	12.24
Cc	1.38
Cu	2.603
D_{60}	0.60
D_{10}	0.23
Gravel	7.9%
Silt	0%
Clay	9.8%
Shear Strength	1.565 n/cm^2
UCS	0.145 n/cm^2
CBR(Socked) 2.5mm	1.81
5.0mm	2.53
CBR(un socked)2.5mm	1.86
5.0mm	2.39
Specific gravity	1.95
Saturation Ratio	16.66%
OMC	12%
Dry density	1.98g/m^3
Co –Efficient of permeability	0.01458 mm/sec

Table 2: *Liquid Limit and Plastic Limit Values for Fly Ash and BFA.*

% of Soil	% of Fly Ash	% of BFA	Liquid Limit	Plastic Limit
100	0	0	23.6	28.21
80	10	10	21.8	23.07
70	10	20	20.8	33.03
60	10	30	18.8	26.28
50	10	40	21.8	28.27
40	10	50	24.2	38.31

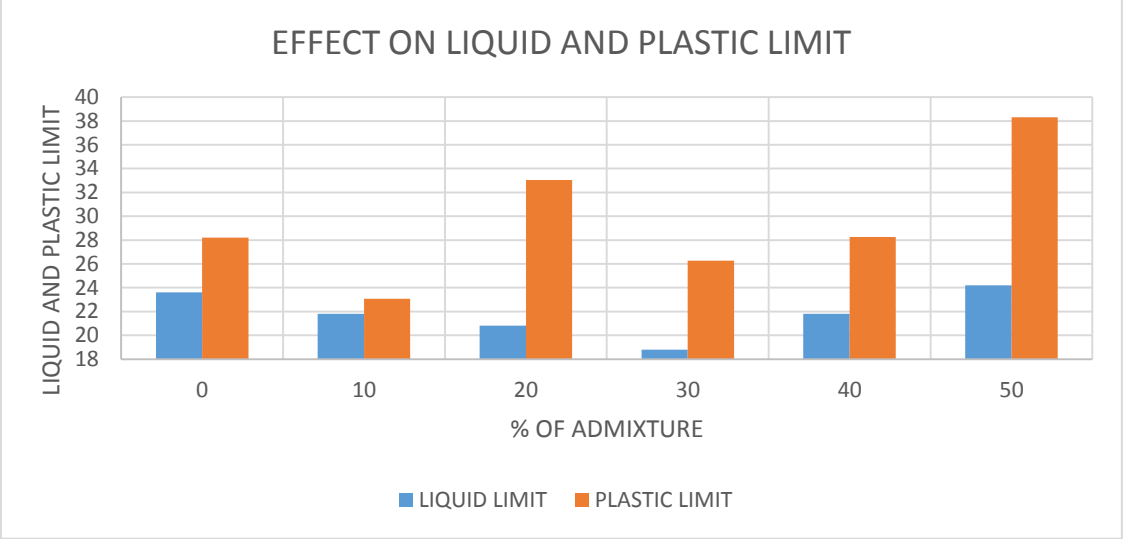

Fig 1: *Liquid and Plastic Limit Distribution Chart for Fly Ash and BFA.*

Specific gravity

Specific gravity is the ratio between the unit weights of soil to the unit weight of known materials like water.

The specific gravity of the soil with varying percentage of Fly Ash and Precipitated silica is given in Table 3 and Figure 2.

Table 3: *Specific Gravity Values for Fly Ash and BFA.*

% of Soil	% of Fly Ash	% of BFA	Specific Gravity
100	10	0	1.55
80	10	10	1.59
70	10	20	1.56
60	10	30	1.73
50	10	40	2.15
40	10	50	1.64

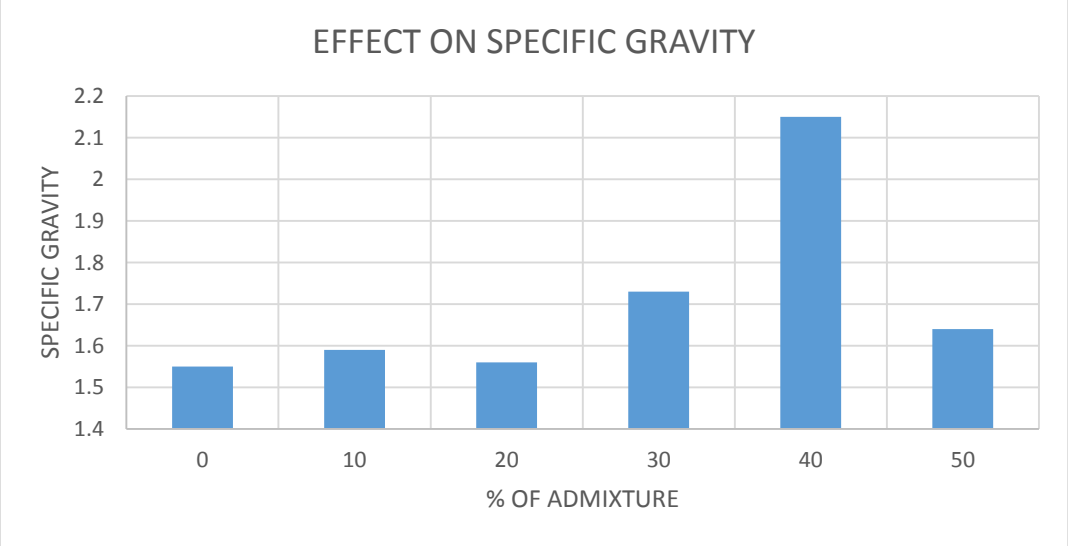

Fig. 2: *Specific Gravity Chart for Soil Fly Ash and BFA.*

Proctor compaction test

The OMC (optimum moisture content) is calculated by the proctor test. The optimum moisture content is the point at which the soil has its maximum strength. The OMC of the soil with varying percentage of Fly Ash and Precipitated silica is given in Table 4 and Figure 3.

Table 4: *OMC and Dry Density Values for Fly Ash and BFA.*

% of Soil	% of Fly Ash	% of BFA	O.M.C %	Max. Dry Density (g/cc)
100	0	0	11	1.98
80	10	10	12	1.99
70	10	20	13	1.8
60	10	30	11	1.8
50	10	40	14	1.88
40	10	50	13	1.876

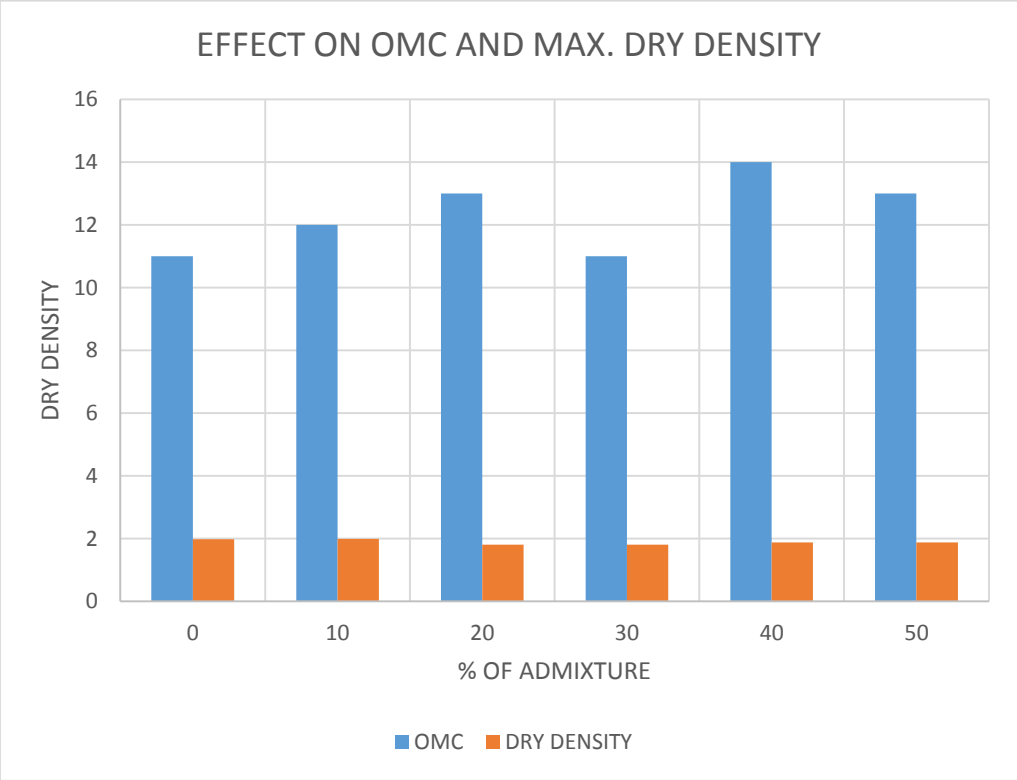

Fig. 3: *OMC and Max. Dry Density Chart for Fly Ash and BFA.*

CBR- California Bearing Ratio

The CBR of the soil with varying percentage of Fly Ash and Precipitated silica is given in Table 5 and Figure 4.

Fig. 5: *CBR (Soaked and Unsoaked) Value for Fly Ash and BFA.*

% of Soil	% of Fly Ash	% of BFA	CBR Value (Unsoaked)	CBR Value (soaked)
100	0	0	1.86	1.81
80	10	10	0.74	1.63
70	10	20	0.767	0.6235
60	10	30	1.64	0.6354
50	10	40	1.3	2.26
40	10	50	2.11	6.18

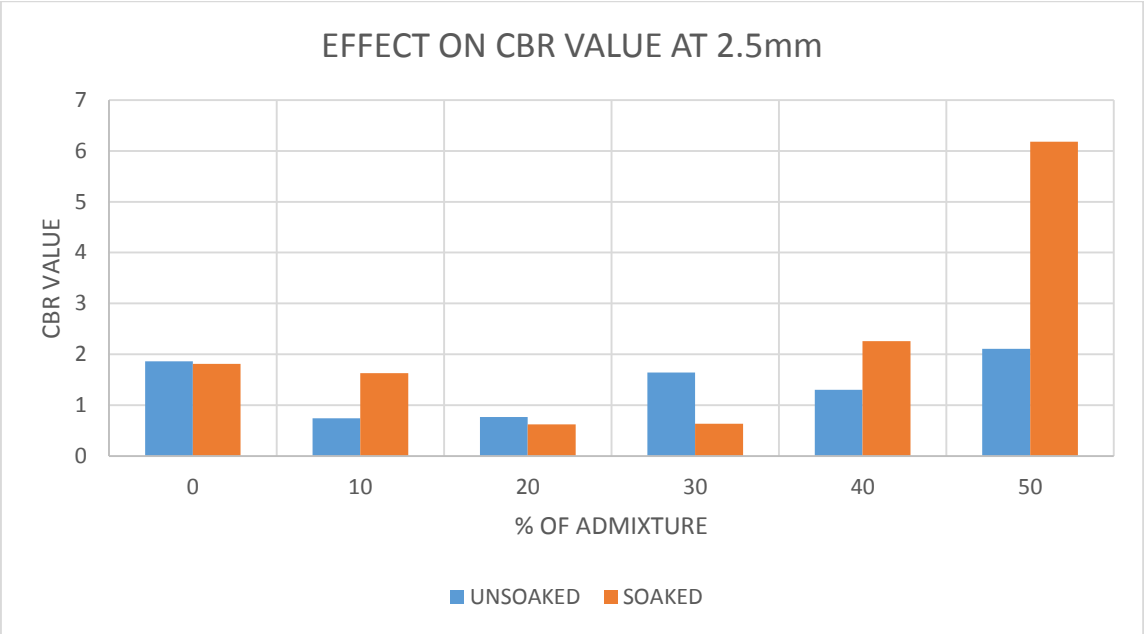

Fig 4: *CBR Chart for Fly Ash and BFS (Unsoaked & Soaked).*

CONCLUSION

Red soils are mostly unsuitable for engineering construction but in many cases their use in construction above them is being promoted. To avoid any failure this soil should be stabilized to increase the bearing capacity. The results obtained in the present research proved that Red soil can be stabilized by using industrial by-products like fly ash and BFA. The addition of these materials has an impact on OMC, liquid limit, plastic limit, maximum dry density and CBR value.

A mixture of 40% soil, 10% fly ash & 50% BFA provided an effective stabilization with the highest CBR value of 6.18. Hence, the utilization of BFA is suggested in tandem with fly ash for soil stabilization.

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