SOIL IMPROVEMENT USING RED MUD AND FLYASH

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ABSTRACT: The major ill effect of global Industrialization and Urbanization processes leads the production of large quantities of industrial wastes and the problems related with their safe management and disposal. Among such type of hazardous industrial wastes Red Mud is the one. Red Mud is produced in the Bayer process of extraction of alumina from bauxite, the insoluble product generated after bauxite digestion with sodium hydroxide at elevated temperature and pressure is known as "red mud". With increasing production of red mud, the environmental problems caused by it are increasing seriously, and thus the integrated treatment of red mud is imminent. Globally, aluminum industries are producing approximately 75 million tons of red mud every year. Less than half of this is used. Storage of this unutilized red mud apart from covering vast tracks of usable land also pollutes land and water in the vicinity. Thus, through this paper an attempt has been made in the study to utilize the Red Mud mixed with Fly Ash in soil stabilization. It is found that Red Mud when mixed with Fly Ash improves the strength of low bearing soil.

Keywords: Red Mud, Utilization, Fly Ash, Soil Stabilization.

INTRODUCTION

Highly compressible soils are considered to be marginal because they lack the required engineering properties for use in pavement base courses, sub-base courses, subgrades, and as a foundation supporting layer under buildings and various structures and for landfilling. Engineers and practitioners are continually looking for methods to improve the properties of fine grained soils. Traditional stabilization techniques require large amounts of additives and specialized skills and equipment to ensure adequate performance (Tutumluer et al., 2004). This Paper is a work of using Red Mud and Fly Ash mixture together for improving highly compressible soil. This technology is non-traditional, and requires minimal installation equipment. For soil stabilization and improvement purposes, Fly Ash have been used extensively due to their low cost, light weight, and significant contribution to strength gain. The addition of Fly Ash increases the load bearing capacity of soil.

Experimental Program

An extensive experimental program was carried out to investigate the strength improvement of a compressible soil by adding Red Mud and fly ash.

Material used:

a) Soil

The soil sample which was collected from Ravindra Nagar (Dhoos) Kushinagar. The engineering property of the soil is given in Table 1.

Table 1 Engineering properties of soil

Sr. No.	Properties	Typical Values
1	Grain size analysis	
	a) Fine gravel size (10 mm to 4.75 mm)	NIL
	b) Sand size (4.75 mm to 75 microns)	2.40%
	c) Silt size (75 microns to 1 microns)	97.60%
2	Atterberg limits	NP(Non Plastic)
3	Specific gravity, G	2.05
4	Maximum Dry Density (MDD)	1.699 g/cc
5	Optimum Moisture Content (OMC)	17%
6	California Bearing Ratio (CBR)	1.8%
7	Permeability, k	3.832×10^{-6} cm/sec

a) Red Mud

This sample of Red Mud has been obtained from HINDALCO, Renukoot (U.P.). This Red mud is the solid waste residue of the digestion of bauxite ores with caustic soda for alumina (Al2O3) production. It is a mixture of compounds originally present in the parent mineral bauxite and of compounds formed or introduced during the Bayer cycle.

The engineering properties and chemical composition of the flyash is given in table 2 and 3 respectively.

Table 2 Engineering properties of Red Mud

Sr. No.	Properties	Typical Values
1	Red Mud Grain size	(0.7-100) micro meter
2	Atterberg limits	NP
3	Specific gravity, G	2.7
4	Maximum Dry Density (MDD)	1.712 g/cc
5	Optimum Moisture Content (OMC)	30.5 %
6	Cohesion (kg/cm^2)	0.125
7	Angle of internal friction (in degree)	26.8
6	California Bearing Ratio (CBR)	3.368
7	Permeability, k	5.7832×10^{-7} cm/sec

Table 3 Composition of material in Red Mud

Table 2: Typical Chemical Composition of Red Mud	
Composition	**Percentage**
Fe_2O_3	30-60%
Al_2O_3	10-20%
SiO_2	3-50%
Na_2O	2-10%
CaO	2-8%
TiO_2	12-25%

a) Fly Ash

The fly ash used in the study was brought from Tanda Thermal Power Station situated at Ambedkar Nagar in Uttar Pradesh, which was available free of cost. Fly Ash is classified as silt of low compressibility. Fly Ash from Electrostatic Precipitator (ESP) is continuously removed to buffer hopers located near ESP by means of vacuum pumps. From buffer hoppers, dry fly ash is conveyed to storage silos, from there it can be unloaded dry to pneumatic tank trucks or conditioned with water by hydro mix dust conditioners for discharge to open bed trucks, Ash to be stored is removed by belt conveyers to ash storage area. Bottom ash is continuously collected in wet hoppers, ground to sand size and periodically transferred to one of six hydro bins for decanting.

The chemical property of the fly ash is highly influenced by the chemical content of the coal burned. (i.e., anthracite, bituminous, lignite).The free lime content of fly ash contribute to self-hardening, fraction of lime, present as free lime in the form of calcium oxide or calcium hydroxide, controls self- hardening characteristics of fly ashes.

The Geotechnical Engineering properties and chemical composition of Fly ash are given in table 4 and table 5 respectively.

Table 4 Geotechnical Engineering properties of Fly Ash

S.No.	Properties	Value
1	Colour	Grey
2	Percent passing 75μ sieve	76%
3	Size of particle	0.002-0.30mm
4	Maximum Dry Density (MDD)	1.222 g/cc
5	Optimum Moisture Content	16.4 %
6	Specific Gravity	1.986
8	Atterberg Limit	NP

Table 5 Composition of Fly Ash

Sr. No.	Chemical Requirements	% By Weight
1	Silicon dioxide (SiO2) plus Aluminum oxide (Al2O3)+ Iron oxide (Fe2O3)	70.0%
2	Magnesium oxide (Mgo)	5.0%
3	sulphurtrioxide (SO3)	3.0%
4	Sodium oxide (Na2O)	1.5%

Result and Discussion

Different percentage at which Fly Ash was mixed with soil and its OMC and CBR is given in Table 6. From the table and graph it is clear that strength of the mixture is maximum when 30%

Red Mud and 3% is Fly Ash added to the 67 % of soil. On the basis of past research (Sharif, 2012) we found that 2% Fly ash mixing gives the best result in soil stabilization therefore we mix 2% geofiber in different percentage of soil and fly ash.

Table 6 Variation of OMC%, MDD and CBR% with Red Mud Content

Sr.No.	Denoted	% Red Mud	% Soil	% Fly Ash	OMC %	MDD g/cc	CBR %
1	-	100	0	0	30.5	1.712	3.368
2	-	0	100	0	18.38	1.699	1.8
3	-	0	0	100	20.61	1.23	1.01
4	M1	3	94	3	19.8	1.685	3.124
5	M2	6	91	3	20.5	1.6857	3.924
6	M3	12	85	3	21.2	1.6865	4.856
7	M4	18	79	3	21.5	1.687	5.957
8	M5	24	73	3	21.7	1.6880	6.856
9	M6	30	67	3	22.1	1.6888	7.354
10	M7	36	61	3	22.4	1.6896	6.654

From the above table it is also observed that the CBR Value for the Fly Ash is less than CBR value of Red Mud, and Dry density value of Red Mud is higher than Dry density value of the soil. Thus these results also shown an indication that Red Mud can be a best material for Geotechnical purposes and even in Road construction works.

Form the above table following information can be drawn:

- With increase in percentage concentration of Red Mud, Optimum moisture content of the mixture (Red Mud + Fly Ash + Soil) increases.
- With increase in concentration of Red mud, Maximum dry density of mixture increases.

With increase in concentration of red mud, California bearing ratio first increase up to a fixed concentration of Red mud and again increase in concentration of red mud leads to decrease in CBR value.

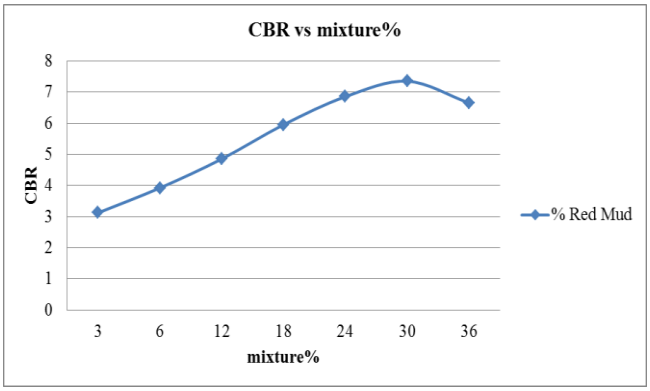

Fig. 1 % of mixture and CBR curve

The CBR (California Bearing Ratio) is a penetration test for evaluation of mechanical strength of the road and Subgrade base coerces. The test is performed by measuring pressure required to penetrate a soil sample with plunger of standard area. The CBR was developed for measuring the load bearing capacity of soil. Initially 3% Red Mud is added to soil and 3% fly ash then CBR Value is 3.124 after then 6%, 12%, 18%, 24%, 30%, 36% Red Mud added to soil and 3% Fly ash then CBR value are 3.924,4.856,5.957,6.856,7.354,6.654 respectively obtained.

Thus 30% of Red Mud mixing and CBR value of 7.354 can be selected as optimum value with soil and Fly ash for better improvement of soil and its stabilization.

Conclusion

The mix containing 30% Red Mud + 67% Soil + 3% Fly Ash has good bearing strength characteristics. In order to achieve good quality structural fills, the MDD values obtained from standard proctor test may be adopted as a benchmark value. The bearing strengths of Red Mud were increased to 7.354% on addition of Red Mud and Fly Ash in the ratios of 30% and 3% respectively.

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