International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 04 Issue: 03 | Mar -2017 www.irjet.net p-ISSN: 2395-0072

EVALUATION OF GEOTECHNICAL CHARACTERISTICS OF RED MUD LIME SOIL MIXTURE

[1]Aman Jain [2]Prof. Rajesh Jain

[1]ME scholar,[2]Associate Professor
Jabalpur Engg. College,Jabalpur Engineering College, Jabalpur

Abstract: *Red mud is a waste residue produced in the process of extraction of alumina from bauxite. The process is called Bayer's Process. It is insoluble waste product and is produced after bauxite digestion with sodium hydroxide at high temperature and pressure. This paper describes the characteristic properties of Red Mud and possible use as a filling and backfill material in various geotechnical purposes. Basics properties like Specific gravity, Particle size distribution, Consistency's limit, OMC and MDD are determined and Engineering properties like Permeability and CBR values are also determined in confirmity with the Indian Standard Code and test results are discussed in geotechnical point of view. It revealed that the behavior of red mud is same as that of Black cotton soil with considerably high strength compared to conventional BC soil.*

Keywords: Bauxite residue, Red mud utilization, geotechnical materials, environmental safety.

INTRODUCTION:

Industrialization and urbanization are the two world wide phenomena. Though these are the necessity of the society and are mostly inevitable, one has to look into their negative impacts on the global environment and social life. The major ill effect of these global processes is the production of large quantities of industrial wastes and the problems related with their safe management and disposal. Second problem is the scarcity of land, materials and resources for ongoing developmental activities, including infrastructure.

Red mud is waste product in the slurry form produced during the process for alumina production. Depending on the raw material processed, 1–2.5 tons of red mud is generated per ton of alumina produced [1]. In India, about 4.71 million tons/annum of red mud is produced which is 6.25% of world's total digestion with sodium hydroxide at high temperature and pressure [2]. It is a mixture of compounds originally present in the parent mineral bauxite and of compounds formed or introduced during the Bayer's process. It is disposed as slurry having a solid concentration in the range of 10-30%, pH in the range of 10-13 and high ionic strength. Considerable research and development work for the storage, disposal and utilization of red mud is being carried out all over the world [3]. This article provides an overview of the basic characteristics of red mud. The main ways of comprehensive utilization are also summarized. It describes the progress of experimental research and comprehensive utilization. The aim is to provide some valuable information to further address the comprehensive utilization of red mud.

Table1 listed out the chemical and mineral composition of red mud that are produced by Bayer's process [4].

Table-1: Chemical Composition of Red mud

Composition	Percentage (%)
Fe_2O_3	30-60%
Al_2O_3	10-20%
SiO_2	3-5%
Na_2O	2-10%
CaO	2-8%

Based on the past study, there is an improvement in the soil behavior by introducing the lime [5]. Lime has been known as one of the good soil stabilization materials, especially for clay stabilization properties that have a swelling and generally its swelling properties will be much reduced, even if the soil mixed with lime. The presence of Ca^{+2} cations on the elements of lime can provide bonding between the particles that expands on soil properties [6] and [7].

MATERIALS: Soil, Red Mud and lime.

PROPERTIES OF RED MUD:

Table-2: Different Properties of red mud are discussed below:

S.NO.	PROPERTY	VALUE
1	Specific Gravity	3.04
2	Atterberg's Limit	NP
3	Optimum Moisture Content (%)	27.03
4	Maximum Dry Density (g/cc)	1.65
5	California Bearing Ratio	3.27
6	Permeability (cm/sec)	$1.12x10^{-5}$

PROPERTIES OF SOIL:

Table-3: Different characteristics of soil which are determined in laboratory are tabulated below:

S.NO.	PROPERTY	VALUE
1	Specific Gravity	2.68
2	Liquid Limit (%)	60.5
3	Plastic Limit (%)	30.145
4	Plasticity Index (%)	30.533
5	Differential Free Swell (%)	71.43
6	Optimum Moisture Content (%)	16.93
7	Maximum Dry Density (g/cc)	1.813
8	California Bearing Ratio	2.37

SAMPLE PREPARATION:

Table-4: Samples were made with the different percentage of Soil with different percentage of red mud and lime as tabulated below:

S.NO.	SYMBOL DENOTED	MIX PROPOTION
1	S1	100% Red Mud
2	S2	100% Soil
3	S3	97% Soil + 3% Lime
4	S4	87% Soil + 10% Red Mud+ 3% Lime
5	S5	77% Soil + 20% Red Mud+ 3% Lime
6	S6	67% Soil + 30% Red Mud+ 3% Lime
7	S7	57% Soil + 40% Red Mud+ 3% Lime

RESULT AND DISCUSSION:

The experimental results shown on the Table below:

Table-5: Compaction Characteristics of Soil Red mud mixture:

S.NO.	MIX	OMC(%)	MDD(g/cc)	CBR(%)
1	S1	27.03	1.65	3.26
2	S2	16.93	1.813	2.37
3	S3	14.72	1.83	10.67
4	S4	18.35	1.782	16.15
5	S5	17.50	1.811	22.81
6	S6	16.97	1.823	10.67
7	S7	16.65	1.83	9.927

Optimum moisture content:

The Optimum moisture content of the red mud sample was **27.03%** which was very high when we compared with any conventional clay sample. Based on the past study, Gati Sri Uttami[8] done the stabilization of clay with lime and as we seen from the Table 5 and graph,the optimum moisture content of the soil sample was **16.93%** which reduces to **14.72%** by introducing 3% lime which showed that on increasing the lime, OMC decreases. The sample is further stabilized with Red mud, on increasing the percentage of red mud from 10% to 40%, the behavior of OMC shown on the Table 5.

Maximum Dry Density:

The Maximum dry density of red mud sample is **1.65g/cc** which is good, the MDD of the soil sample was **1.813g/cc** which goes to **1.83g/cc** by adding 3% lime. From graph, while increasing the red mud from 10 to 40% the MDD of the sample were increased from **1.782g/cc** to **1.83g/cc**, due to the presence of Iron oxide (Fe_2O_3). The results were achieved at different proportion shown on Table 5 and figure.

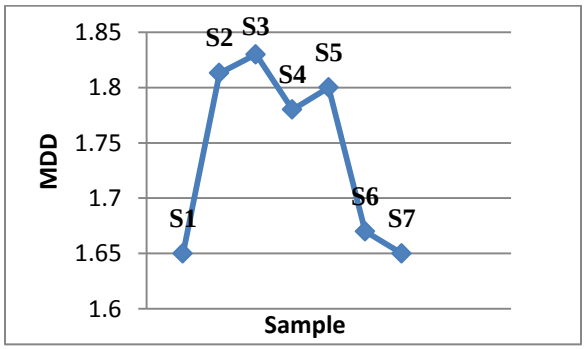

Fig 1: Variation of MDD with mix

California Bearing Ratio:

The CBR value of red mud is **3.26%** and that of soil is **2.37%** which is more when compared to soil, with the addition of 3% lime to the soil sample its value increases to **10.67%**. And with further increasing the percentage of red mud to the soil lime mixture from 10 to 40%, the value increases upto **22.81%**, afterwards its value decreases shown on graph below.

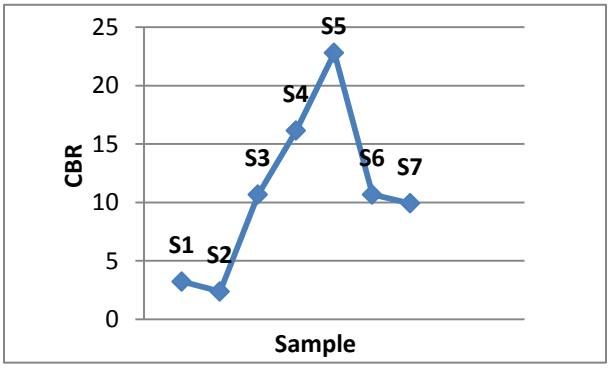

Fig 2: Variation of CBR and sample.

By increasing the red mud upto 40% to the soil with 3% lime, the best results were come out at 20% red mud soil mixture. At this proportion the MDD and CBR value increases upto **1.811g/cc** and **22.81%** respectively at OMC of **17.50%**.

CONCLUSION:

With the aim to utilize the Aluminium Plant Industrial waste such as Red Mud from HINDALCO Pvt. Ltd., Renukoot, Uttar Pradesh for Utilization as stabilized Material in Road construction and other engineering application. Based on the experimental study, it is found that Red Mud waste may be utilized well in soil stabilization and other Geotechnical Engineering projects by mixing Red Mud with Soil and Lime. Thus this method of utilization may resolve major environmental problem of Disposal of Red Mud waste Obtained from Aluminium companies.

Based on the Experimental results, the following conclusion may be come out:

- The specific gravity of red mud is high as compared to soil, so the density and strength of red mud is also more. Therefore it may be utilized as subgrade material for better strength.
- The coefficient of permeability of red mud is **$1.12x10^{-5}$cm/s** which is low so it can be used as a filling material in embankment.
- While increasing the percentage of red mud in the soil sample with 3% lime, the best results were obtained at 20% red mud soil mixture with MDD value of **1.811g/cc** and CBR value of **22.81%** at OMC of **17.50%**.
- As seen from the graph and table the red mud is utilized with lime to enhanced the behavior of soil strata for better results.
- The MDD and CBR value of red mud which was also good so it may used as a replacement of poor subgrade soil.
- By seeing all these properties we can use red mud as a geotechnical material such as filling material for embankment, subgrade material for pavement etc.
- Red mud can be further stabilized with fly ash, gypsum etc.

REFERENCES:

1. Paramguru R.K, Rath P.C, and Misra V.N. "Trends in red mud utilization - a review," Mineral Processing & Extractive Metallurgy Review, vol. 26, no. 1, pp. 1–29, 2005.
2. Parlikar U.V, Saka P.K, and Khadilkar S.A. "Technological options for effective utilization of bauxite residue (Red mud) - a review," in International Seminar on Bauxite Residue (RED MUD), Goa, India, October 2011.
3. Rai Suchita, Wasewar K.L, Mukhopadhyay J, Chang Kyoo Yoo, Hasan Uslu "Neutralization and utilization of red mud for its better waste management" Arch. Environ. Sci. (2012), 6, 13-33
4. Hind A.R, Bhargava S.K, Stephen C. Grocott, The surface chemistry of Bayer Process solids a review. Colloids and surfaces A: Physicochem Eng. Aspects, 146 (1999). 359-374.
5. Warsiti. 2009 Improving CBR and Decreases Swelling Soil subgrade with soil stability Methods using Lime. (Online), 14(1): 38-45.
6. Ruckman A. 1980, Summary of Open Discussion, session no.5. Proceeding of the fourth International Conference on Expansive Soils. 11:717-720.

7. Ingles O.G. Dan, Metcalf J.B. 1972. Soil Stabilization Principles and Practice Butterworths Pty. Limited, Melbourne.

8. Gati Sri Uttami 2014, " Clay soil stabilization with lime effect the CBR valu and swelling" ARPN journal oct. 2014.