An Experimental Study on Industrial Waste as Filling Material

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ABSTRACT

Before processing and manufacturing, Industries is disposal of waste products. Red mud is a byproduct produced in the process of extraction of alumina from bauxite ore. Pond ash is a waste material from thermal power plant and is mainly obtained from the wet disposal of the fly ash and disposed off in large pond as slurry. Red mud and pond ash are examined for the different geotechnical properties. After characterization of red mud and pond ash samples for their individual geotechnical properties, Experiments will be carried out separately for red mud, pond ash and both mix in varying proportions. Standard proctor compaction tests and unconfined compression strength test will be carried out for finding the compaction character and shear strength of the mixes as filling material. The optimum mix of red mud and pond ash for the purpose of construction of embankment.

Keywords *– Compaction tests, compression test, Filling material, Pond ash and Red mud.*

I. INTRODUCTION

Out of various production industries, the ore dressing mineral processing industries are the major contributors towards disposal of toxic waste product.

Beneficial use involves the application of a secondary material from an industrial process, which generally may be viewed as a conceivably waste, as a building block in another process. The major ill effect of these global processes is the generation of extensive amounts of industrial wastes and the issues related with their safe management and disposal.

Technology can utilize the industrial wastes like red mud and pond ash in the industries have to incur heavy expenses in terms of land and space, economy an…0000000d government and international norms which cause comprehensive reduction in the profit margin.

Industrial wastes like red mud and pond ash have potential applications in distinctive ranges like filling material. For fruitful utilization of the waste material as fill in structural designing development, knowledge of compaction characteristics and shear strength of the fill material is essential to achieve in the field. The samples collected from the sites are characterized for their geotechnical properties.

1.1 Red Mud

Red mud is a byproduct produced in the process of extraction of alumina from bauxite ore.

1.1.1 Chemical Composition of Red Mud

Composition	Percentage
Fe_2O_3	30-60%
Al_2O_3	10-20%
SiO_2	4-50%
Na_2O	2-10%
CaO	2-8%
TiO_2	25%

1.2 Pond ash

Pond ash is a waste material from thermal power plant and is mainly obtained from the wet disposal of the fly ash and disposed of in large pond as slurry.

1.2.1 Chemical Property of Pond Ash

Composition	Percentage
Fe_2O_3	3.5-34.6%
Al_2O_3	1.38-18%
SiO2	3-45%
Na_2O	0.05-0.31%
CaO	0.2-0.6%
TiO_2	0.2-1.4%

II. LITERATURE REVIEW

Kusum Deelwal, Kishan Dharavath, Mukul Kulshreshtha. Red mud is a byproduct produced in the process of extraction of alumina from bauxite. The process is called Bayer's Process. It insoluble product and is generated after bauxite digestion with sodium hydroxide at elevated temperature and pressure. This paper describes the characteristic properties of Red Mud and possible use as a geotechnical material. Basics properties like Specific gravity, Particle size distribution, Atterberg's limit, OMC and MDD are determined. Engineering properties like shear strength, are also determined in conformity with the Indian Standard Code and test results are discussed in geotechnical point of view. It revealed that the behavior of red mud is likely as clay soil with considerably high strength compared to conventional clay soil.

Ping Wang and Dong-Yan Liu .Performances of two common types of red mud, Bayer red mud and Sintering red mud were investigated in this research. Their compositions, mechanical properties and microstructure characterization were measured through XRD, TG and SEM analysis. Their shear strength, particle size, density and hydraulic characteristics also had been performed. Huge differences between the basic mineral types of these two kinds of red mud also can be found. The comparison of compositions shows that CaCO3 content in Sintering red mud is higher, Bayer red mud has more hazardous elements such as As, Pb and Hg and both have a high concentration of radioactivity. The micro particle of Bayer red mud is finer and more disperse, but the Sintering red mud has higher shear strength. Combining the TG and hydraulic characteristics analysis, it can be shown that Bayer red mud has higher value of water content and Sintering red mud has higher hydraulic conductivity. The paper then illustrates that Sintering red mud can become the main filling material of supporting structure of red mud stocking yard. Bayer red mud has a high reuse value and also can be used as a mixing material of masonry mortar.

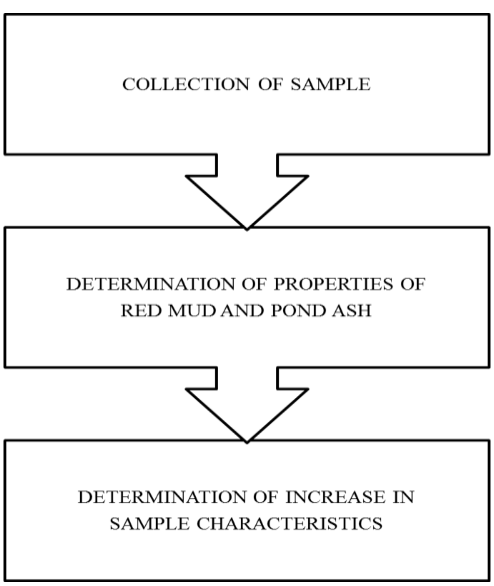
Ekrem Kalka Oltu Vocational Training School,7 July 2006. Red mud is a waste material generated by the Bayer Process widely used to produce alumina from bauxite throughout the world. Approximately, 35% to 40% per ton of bauxite treated using the Bayer Process ends up as red mud waste. Because of storing issues, the waste negatively affects the environment. To solve this problem, it is essential to investigate different uses for red mud waste. The potential use of red mud for the preparation of stabilization material is presented in this study. This study examines the effects of red mud on the unconfined compressive strength, hydraulic conductivity, and swelling percentage of compacted clay liners as a hydraulic barrier. The test results show that compacted clay samples containing red mud and cement–red mud additives have a high compressive strength and decreased the hydraulic conductivity and swelling percentage as compared to natural clay samples. Consequently, it is concluded that red mud and cement–red mud materials can be successfully used for the stabilization of clay liners in geotechnical applications

Gourav Dhane, Arvind Kumar Agnihotri, Akash Priyadarshee, Manish Yadav Volume 1, Number 5; August, 2014. Due to rapid industrialization energy generation is increasing day by day. This energy generation by numerous power plants causes production of industrial waste. Generation of these wastes is a big threat to our society and environment. So we either have to find ways to dump these wastes safely or to use these wastes in a constructive manner. Industrial wastes have been gaining importance as a geotechnical material in the present days. Due to specific advantages, materials like fly ash, pond ash have been considered as a replacement to natural soils. Different research is done on the behavior of soil mixed with these industrial wastes to understand the potential of these waste in the improvement of engineering behaviour of soil. It is found from the studies that these industrial wastes can be used as admixture for the improvement of weak or poor soil. Pond ash is a waste material and it is mainly obtained from the wet disposal of the fly ash, which when get mixed with bottom ash, disposed off in large pond or dykes as slurry. In this paper the review of different studies, where pond ash is used as admixture for the improvement of engineering properties of soil is presented.

Kirkland, Ryan Anderson 2009. There are significant barriers to beneficial use projects; primarily, the environmental evaluation that determines whether the secondary material will be harmful to human health and the environment. The environmental evaluation is most challenging because there is no universally excepted methodology for evaluating secondary materials. The currently accepted testing methodologies. The leaching tests were performed on two mixtures of red mud and phosphogypsum. An initial screening of leaching data is made by comparing test results to documented water quality criteria. Since the leaching test results do not take into account dilution/attenuation factors (DAFs) that are built into water criteria, the screening assessment consisted of calculating the DAF that must be supplied by the release scenario in order to be protective of the environment. Although additional work is needed prior to acceptable application of red mud and phosphor gypsum as alternative construction materials, the assessment approach of this study provides an indication that advanced leaching tests can facilitate evaluation of potential environmental impacts in a beneficial use scenario.

S.P. Singh and A. Sharan 4 July 2011; final version received 30 January 2013.Strength properties of compacted ash layers depend to a great extent on the moulding conditions. This paper focuses on the effects of compaction energy and degree of saturation on strength characteristics of compacted pond ash. The pond ash sample, collected from the ash pond of Rourkela Steel Plant (RSP), was subjected to compactive energies varying from 357 kJ/m3 to 3488 kJ/m3. The optimum moisture content and maximum dry densities corresponding to different compactive energies were determined by conventional compaction tests. The shear strength parameters, unconfined compressive strengths (UCS) and California bearing ratio (CBR) values of specimens compacted to different dry densities and moisture content were assessed and reported. The effects of compaction energy and degree of saturation on shear strength parameters i.e. unit cohesion (cu) and angle of internal friction (F) values and also the UCS values are evaluated and presented herein. The results indicate that the dry density and strength of the compacted pond ash can be suitably modified by controlling the compactive energy and moulding moisture content. The strength achieved in the present study is comparable to the good quality, similar graded conventional earth materials. Hence, it may be safely concluded that pond ash can replace the natural earth materials in geotechnical constructions

III. METHODOLOGY



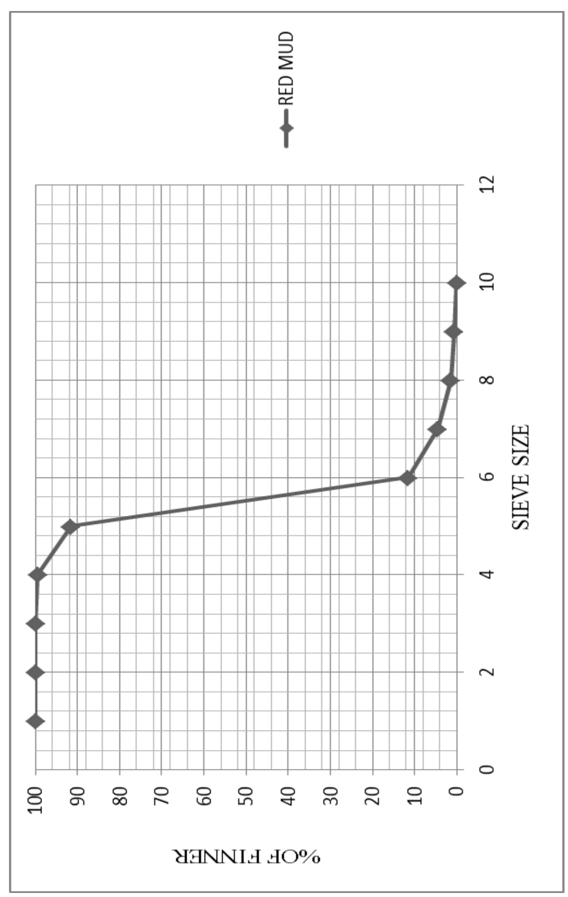
IV. EXPERIMENTAL OBSERVATIONS

4.1 Specific Gravity

Table 4.1 Specific Gravity

S. No.	Observation	Red mud(g)	Pond ash(g)
1	Weight of density bottle (W_1)	20	20
2	Weight of density bottle + sample (W_2)	58	40
3	Weight of density bottle + sample + water (W_3)	100	86
4	Weight of density bottle + water (W_4)	75	75
5	Specific Gravity, G = W2 – W1 /[(W2 – W1) – (W3 – W4)]	2.9	2.2

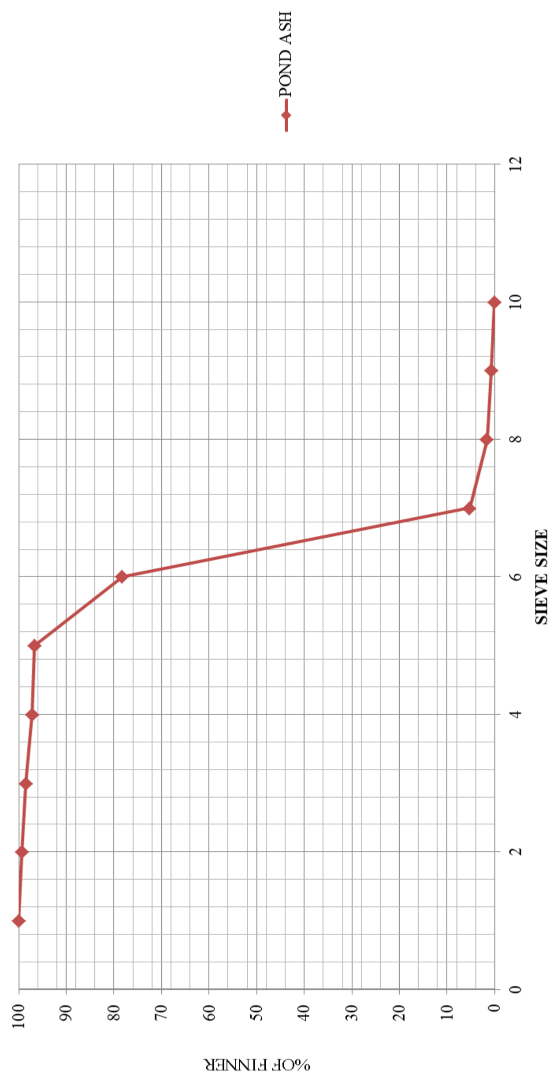
4.2 Particle Size Distribution Of Red Mud



$$Cc = \frac{D30}{D10XD60} = \frac{6.02}{5X5.8} = 1.2$$

$$Cu = \frac{D60}{D10} = \frac{5.2}{6.02} = 0.86$$

4.3 Particle Size Distribution Of Pond Mud



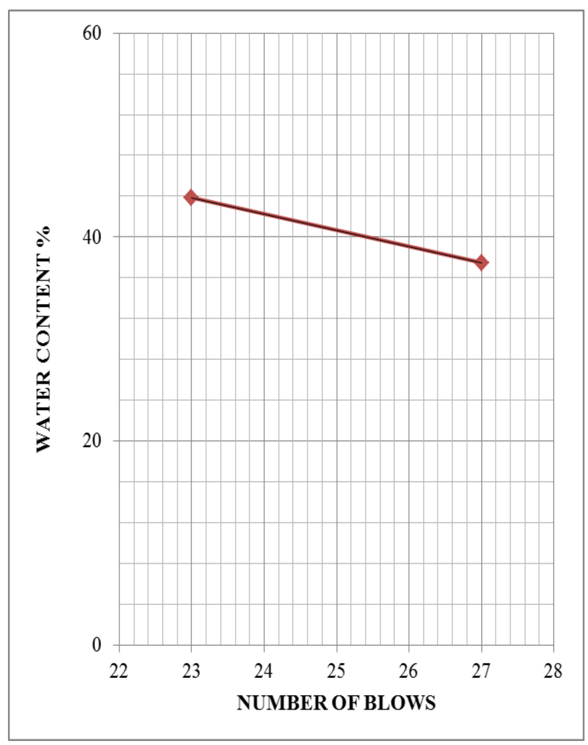
$$Cc = \frac{D30}{D10XD60} = \frac{6.7}{7.4X6.3} = 0.96$$ Cu = $$\frac{D60}{D10} = \frac{6.3}{7.4} = 0.85$$

4.4 Liquid Limit

Table 4.2 Liquid Limit

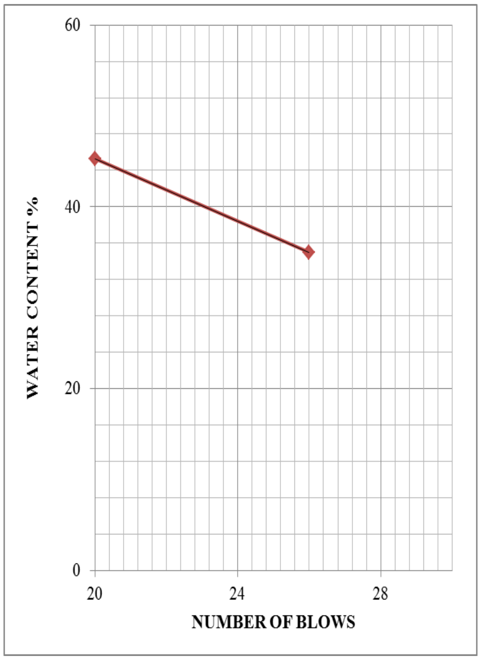
S.No.	Material	Red Mud (g)		Pond ash (g)	
	Determination no.	I	II	I	II
1	No. of blows	23	27	20	26
2	Wt.of container (W_1)	20	20	20	20
3	Wt.of container + Wet sample (W_2)	34.2	31.25	418	37.64
4	Wt.of container + dry sample (W_3)	29.87	28.18	35	33
5	Water Content W = (W_2-W_3)/(W_3-W_1) x 100 %	43.87	37.5	45.3	35

Red Mud



Liquid limit of red mud = 41 %

Pond Ash



Liquid limit of Pond mud = 37 %

4.4 Plastic Limit

Table 4.3 plastic Limit

S.No	Material	Red mud (g)	Pond ash (g)
1	Weight of container (W_1)	21	39.2
2	Weight of container + wet of sample(W_2)	34.8	38
3	Weight of container + dry sample(W_3)	32.7	0.8
4	Weight of water (W_1-W_2)	2.5	35
5	Weight of dry sample(W_2-W_3)	10.2	3.4
6	Water Content $W = W_1 - W_2 / W_2 - W_3$ x 100 %	20.9	23.5

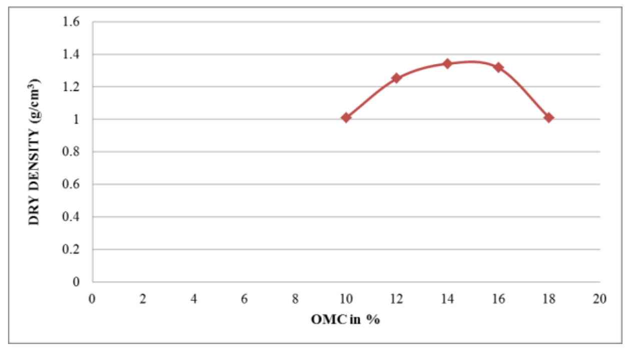
Plasticity Index Of Red Mud

IP = Liquid Limit (WL)-Plastic Limit (WP)
= 40.68-20.9
Ip =19.78%

Plasticity Index of Pond Ash

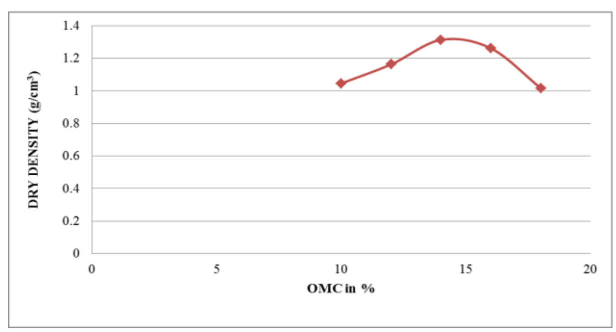
IP = Liquid Limit (WL)-Plastic Limit (WP)
= 40.15-23.5
Ip =16.65%

4.6 Standard Proctor Compaction Test For Red Mud



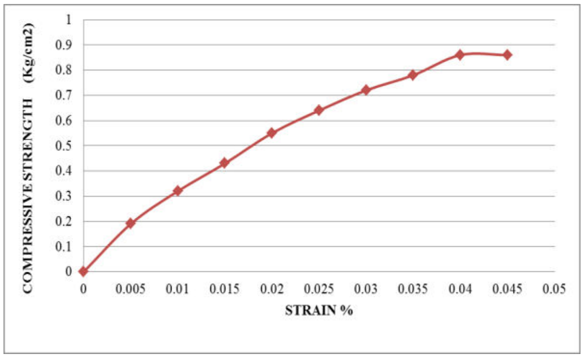
MDD=1.34g/cc
OMC=14.60%

4.7 Standard Proctor Compaction Test For Pond Ash



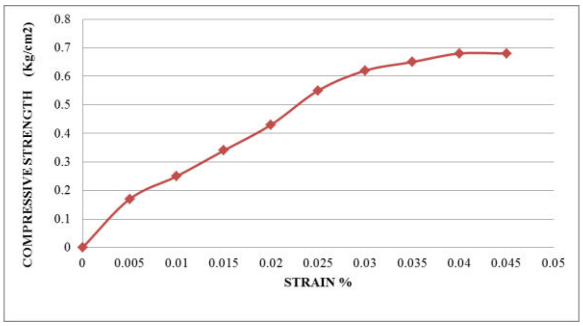
MDD=1.31g/cc
OMC=14.20%

4.8 Unconfined Compression Test For Red Mud



q_u = 0.86 Kg/cm^2

4.9 Unconfined Compression Test for Pond Ash

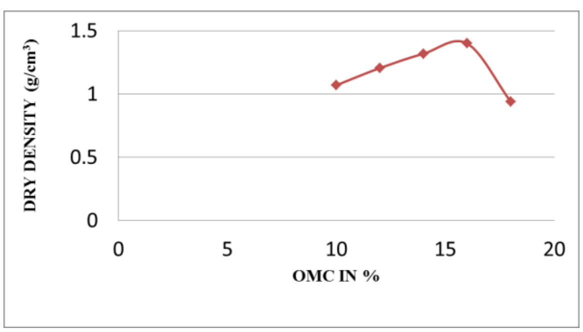


q_u=0.64 Kg/cm^2

V. EXPERIMENTAL ANALYSIS

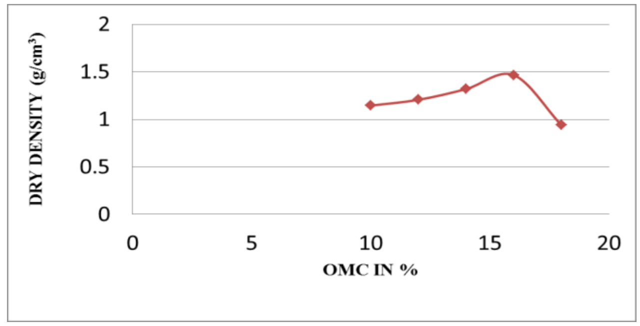
5.1 Standard Proctor Compaction Test

Case 1: 90%RED MUD +10%POND ASH



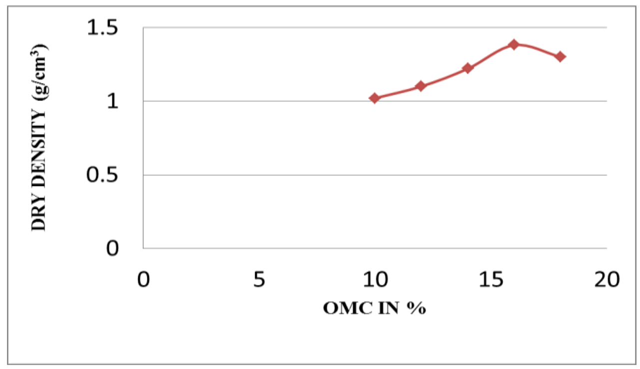
MDD=1.40g/cc
OMC=16.10

Case 2: 80%RED MUD + 20%POND ASH



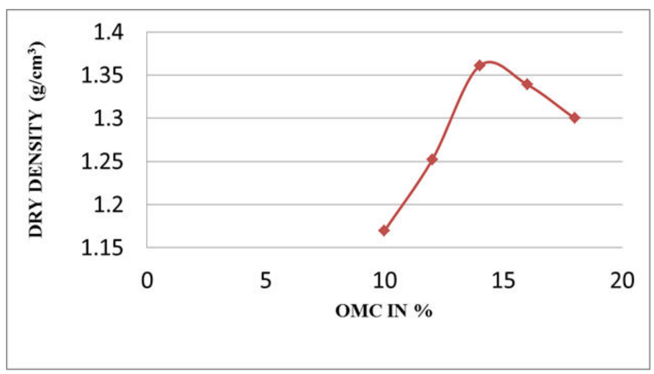
MDD=1.47 g/cc
OMC=16.10%

Case 3: 70%RED MUD +30%POND ASH



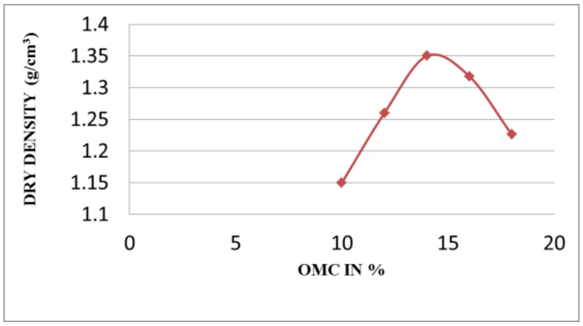
MDD=1.39 g/cc
OMC=16%

Case 4: 60%RED MUD +40%POND ASH



MDD=1.36 g/cc
OMC=13.50

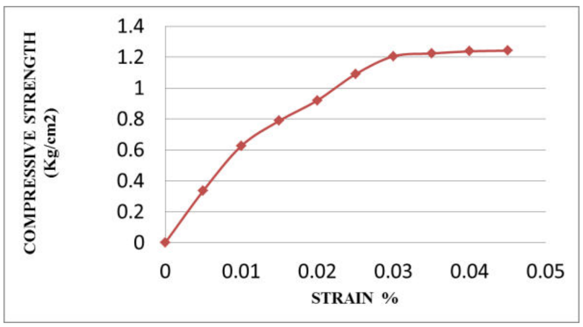
Case 5: 50%RED MUD +50%POND ASH



MDD=1.352g/cc
OMC=13.50 %

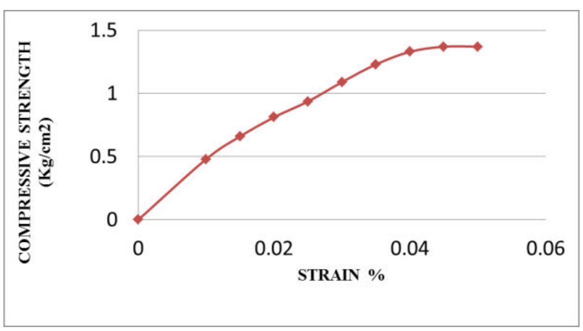
5.2 UNCONFINED COMPRESSION TEST

Case 1: 90%RED MUD + 10%POND ASH



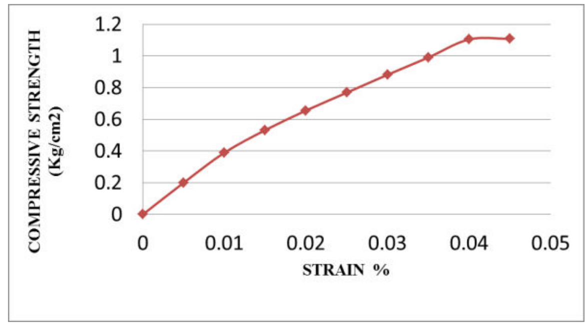
q_u=1.2 Kg/cm^2

Case 2: 80%RED MUD + 20%POND ASH



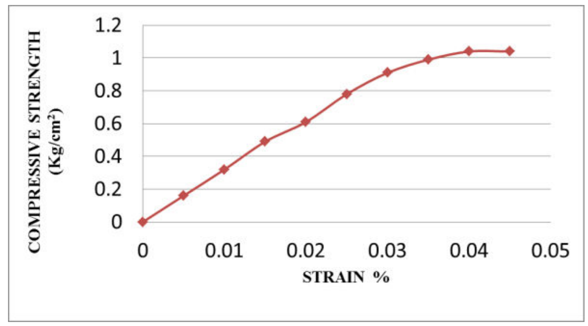
q_u=1.37 Kg/cm^2

Case 3: 70%RED MUD + 30%POND ASH



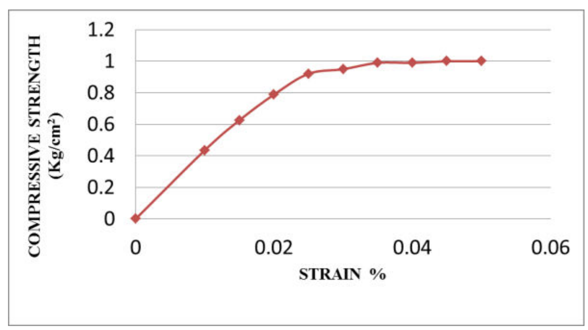
q_u=1.10 Kg/cm^2

Case 4: 60%RED MUD +40%POND ASH



q_u=1.04 Kg/cm^2

Case 5: 50%RED MUD + 50%POND ASH



q_u=0.99 Kg/cm^2

VI. CONCLUSION

The strength parameters are the only governing criteria for filling material. From the analysis of different mix proportions of red mud and pond ash, mix proportion having 80% of red mud and 20% of pond ash shows higher Maximum dry density is 1.47 g/cm^{3}and shear strength is 1.37 Kg/cm^2 . 50% of red mud and 50% of pond ash shows Maximum dry density is 1.17g/cm^{3}and shear strength is 0.64 Kg/cm^2 is the lowest value in the mix proportion. Hence the mix proportion containing

80% of red mud and 20% of pond ash is optimum mix that can be used as filling material.
It is concluded that red mud and pond ash can be considered to be used in ground improvement technique and as fill material which is ecofriendly without causing pollution to the environment.

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