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Comparision Of Engineering Properties Of Red Mud An Aluminium Industrial Waste With Natural Soils

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ABSTRACT
Infrastructure is the backbone for the development of any area. Civil engineering construction activities are come under this category. Construction activities on poor grounds cause distress in the form of settlements and deformations when structures constructed on these soils. To avoid these searching for alternative materials are necessary. In this aspect Red mud is one such alternative for its use in civil engineering infrastructure. In the present work characterization of Red mud is made by performing grain size distribution, compaction, strength, Seepage, CBR and other engineering properties to assess its performance with respect to similar natural soils. It is concluded that Red mud performed effective as an alternative material in place of natural soils.
Keywords – Red mud, Seepage, CBR, Strength

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I. INTRODUCTION

Natural soils are prominent materials for civil engineering construction activities. Some of the soils are loss their strength at saturated conditions. Large deformations in the form of differential settlements have been taking place when structures found on them. There are soils which are unconsolidated in nature have minimum shear strengths under effective stress conditions. In the present study CL, ML soils are come under the above category. such soils used as foundation materials or fill material subjected to deformations encounters high maintenance cost. In such locations industrial wastes like Red mud can be an alternative which is obtained from aluminium industries in large quantities. Some of the researchers have contributed the use of red mud as construction material as listed below.

In recent times several attempts have been made to use Red mud in civil engineering applications. Yang (1996) studied Red mud, Flyash, lime as grout material in filling up of mines. Qi (2005) studied Red mud in highways as construction material. Yang J.K (2006) studied the use of Red mud in pavements. Hanumanth Rao. C.H.V (2012) studied the use of GGBS stabilized Red mud in road construction as sub-base and base course material. Satyanarayana. P.V.V (2012) studied the use of lime stabilized red mud in road construction as sub-base and base course materials. Kusum Deelwal (2014) studied Red mud as Geotechnical material in civil

II. MATERIALS

RED MUD: Red mud is a residue obtained from aluminium industry. It was collected from red mud ponds of NALCO, Dhamanjodi, Orissa, India.
SOILS: Two fine grained soils Silty clay and Clayey silt soils collected from flood banks of river Sarada.

III. EXPERIMENTS:

Red mud, Red soils and Sand samples were dried and the dried samples were tested for physical properties and engineering properties such as gradation as per IS2720-part-4-1985, consistency as per IS2720-part-5-1985, compaction as per IS2720-part-8-1983, shear strength as per IS2720-part-13-1986, CBR as per IS2720-part-16-1987, Seepage as per IS2720-part-17-1986, Swell as per IS2720-part-40-1977,and Compression characteristics as per IS2720-part-15-1986.

IV. RESULTS & DISCUSSION:

The test results of Red mud, Red soils and Sand for the above characteristics are tested & shown in table sand graphs.

Grain size distribution:

Table 1: Grain size distribution

property	Red Mud (ML)	Silty clay (CL)	Clayey silt (ML)
Gravel (%)	0	0	0
Sand (%)	0	05	08

Fines (%)	100	95	92
Silt (%)	90	40	62
Clay (%)	10	55	30

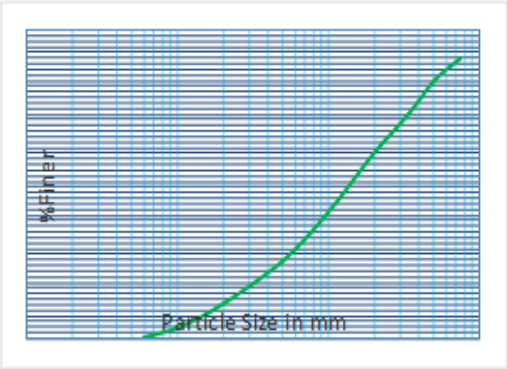

Fig 1: Grain size distribution curve of Red mud

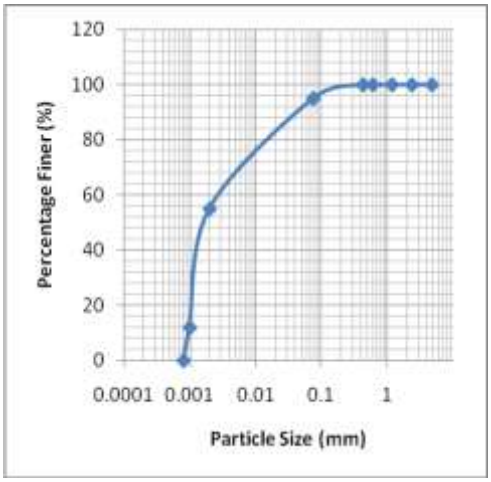

Fig 2: Grain size distribution curve of Silty Clay (ML)

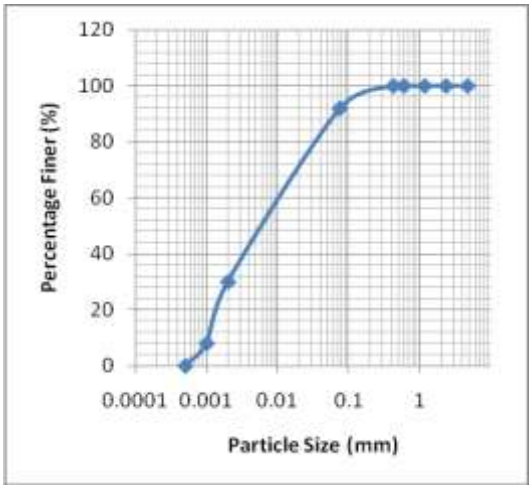

Fig 3: Grain size distribution curve of Clayey Silt (CL)

Based on the grain size distribution of Red mud it is identified that Red mud is a fine grained material dominated by silt size ($75\mu m - 2\mu m$) particles of 90% and clay size ($< 2\mu m$) particles of 10% and absence of sand size ($4.75mm - 75\mu m$) and gravel size (>4.75mm) particles. From the grain size distribution of Silty clay (CL) it has sand particles (1mm-0.075mm) of 5%, silt ($75\mu m - 2\mu m$) particles of 40% and clay size ($< 2\mu m$) particles of 55%, ML soil has sand particles (1mm-0.075mm) of 8%, silt size ($75\mu m - 2\mu m$) particles of 62% and clay size ($< 2\mu m$) particles of 30%.

Table 2: Consistency Characteristics

property	Red Mud (ML)	Silty clay (CL)	Clayey silt (ML)
W_L	32	30	28
W_p	24	20	19
I_p	8	10	9

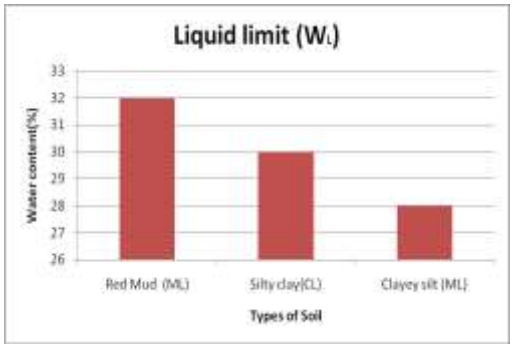

Fig 4: Liquid Limit of Different Soils

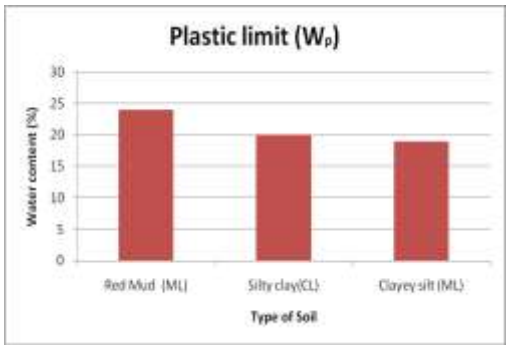

Fig 5: Plastic Limit of Different Soils

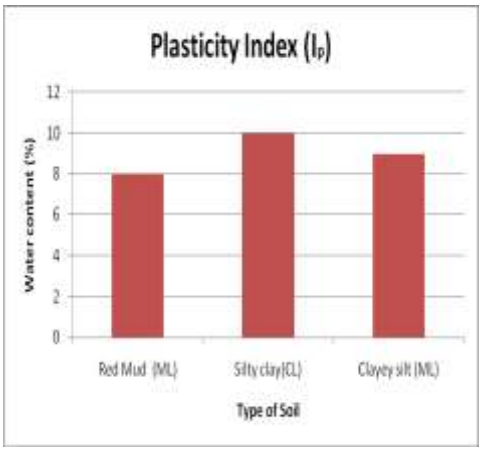

Fig 6: Plasticity Index of Different Soils

Based on the consistency test data, Red mud exhibited low compressible (W_L<35) and low plasticity characteristics (I_p<7) and it is classified as silts of low compressible nature (ML). Whereas natural soils from flood banks of river sarada are Silty clay (CL) is a low compressible and intermediate plasticity soil, Clayey silt (ML) is also a low plastic and low compressible soil. The behaviour of low plasticity, low compressibility can be related to the percentage of clay particles and the presence of clay minerals. Red mud is not having such type of clay minerals. All these three having the behaviour of low compressibility and The difference is related to the mineral and chemical composition of the Industrial waste/soil.

Table 3: Compaction & CBR characteristics

Property	Red Mud (ML)	Silty clay (CL)	Clayey silt (ML)
OMC	22	16.0	15.0
MDD	1.65	1.70	1.68
CBR	5.0	5.0	3.0

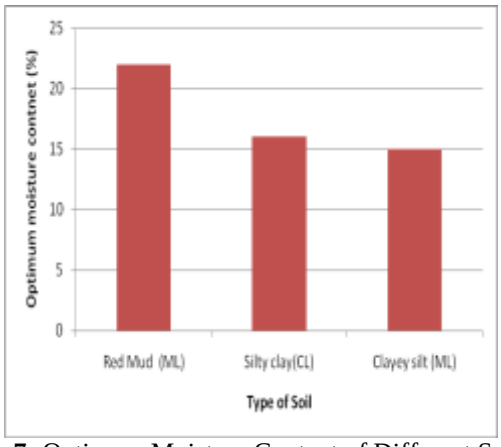

Fig 7: Optimum Moisture Content of Different Soils

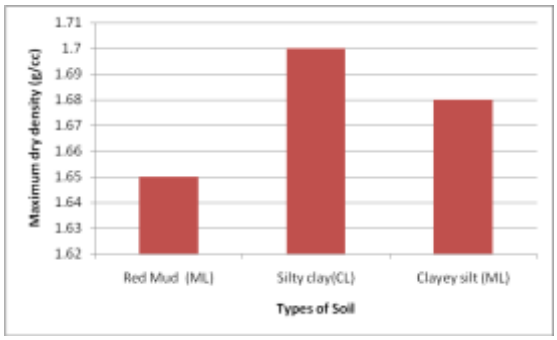

Fig 8: Maximum dry densities of different soils

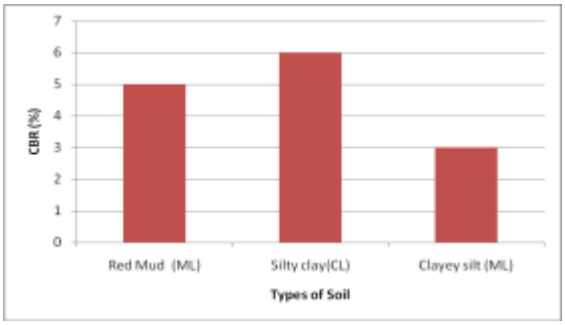

Fig 9: CBR values of different values

Compaction results show that Red mud, Silty clay and clayey silt are attained the amount of maximum dry densities with less variations. Regarding optimum moisture contents Red mud exhibited high OMC value than CL and ML soils. High OMC value is due to fineness of Red mud over other two natural soils.

Based on the test results Red mud exhibited CBR of 5 %. From the test results of Silty clay (CL) has CBR value of 5% whereas clayey silt exhibited CBR values of 3. Basically it is a fine grained material and dominated by silt size particles with very low percentage of clay size particles and reasonably achieved good CBR values against loading. Silty soil attained low shear strength compared to CL soils due to loss of shear strengths with respect to frictional and cohesion in soaked condition.

Table 4: Strength characteristics

property	Red Mud (ML)		Silty clay(CL)		Clayey silt (ML)	
	UU	CD	UU	CD	UU	CD
Cohesion (C)	2.0	0.5	1.8	0.6	1.5	0.5
Angle of shearing Resistance (ø)	32	38	30	28	28	24

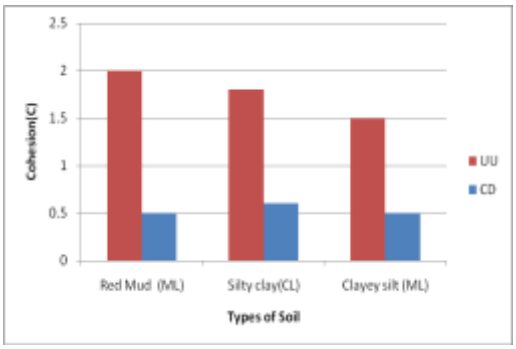

Fig 9: Cohesion values of different soils under UU & CD conditions

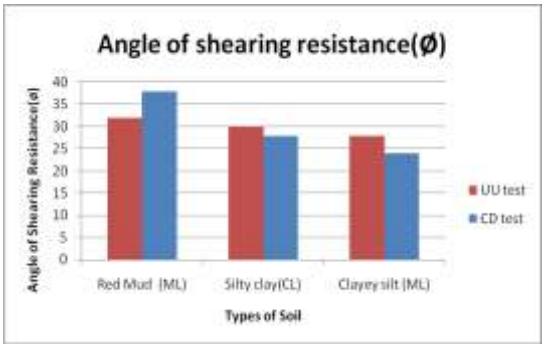

Fig 10: Angle of Shearing Resistance of Different Soils under UU & CD conditions

Based on the test results which are performed at various drainage conditions the following identifications are made. Red mud achieved high shear strength in unconsolidated undrained (UU) as well as consolidated drained tests (CD). Silty clay and Clayey silt have less values of cohesion and frictional components and these soils lost their frictional and cohesive force due to their composition, nature and structure of particles. In Red mud particles the absence of clay minerals helps in increase of effective stress and attained high shear parameters similar to coarse grained soil under effective stress condition due to development of excess pore water pressure which is minimum.

V. ALTERNATE MATERIAL IN PLACE OF CL AND ML SOILS:

Comparing the test results of Red mud (ML) an industrial waste with silty clay (CL) and clayey silt (ML) soils of natural origin the following identifications are made. All these are dominated by silt/ silt size particles.

- Red mud exhibited high OMC & MDD values
- Relatively high CBR values.
- High shear strength values w.r.t undrained and drained conditions.
- High shearing resistance and Bearing capacity values.
- Loss of shear strength UU to drained is small where as in case of natural soils it is more.

The above features are attributed due to the following

Shape and nature of particles effective interlocking between particles which offer more shearing resistance maintaining high densities with wide variation of moisture contents which could helps in maintaining the loss of shear strength is minimum. Some of the chemical compounds binds the particles together which could not seen in case of natural soils.

VI. APPLICATIONS:

- Red mud can be used as fill material, embankment material, foundation material, sub grade material, backfill material as reinforced and unreinforced in retaining wall.
- Reduces thrust on natural soils used as construction material.
- Environmental pollution disposal problems etc.
- Reduces cost of the project.
- Increases the durability of the project by maintaining strength and settlements in tolerable limits.

VII. CONCLUSION:

- Red mud is a silt size dominating industrial waste exhibited high dry density and shear strength values.
- It is impervious, low plastic and low compressible, non-swelling material.
- An alternative material to Red soils and other sandy soils in geotechnical considerations.

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