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Engineering Behavior of Composite of Alluvial Soil and Red Mud Mixtures

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Abstract*—This paper examining the geotechnical properties of composite made up of alluvial soil and red-mud mixtures. Red-mud is an industrial waste by product can be used to enhance engineering properties of alluvial soil. The test specimens are prepared by mixing red-mud with air-dried alluvial soil sample in different proportions varying from 4 to 20% by dry weight of soil. The results indicate that red mud improves the properties of alluvial soil. Moreover it also resolves the waste disposal problem and gainful utilization in improving soil properties.*

Keywords:*—Alluvial soil; Red mud, compressive strength, economical, environmental friendly.*

1. INTRODUCTION

The problem of safe disposal of red mud has increased with the increase in production of alumina. Attempts have been made to utilize red mud by various industries such as ceramic, metallurgical and civil engineering [1]. Alluvial soils are water born deposits, formed by spreading of suspended matter of rivers in their flood plains and deltaic region. On Ganga river belt, there is vast land of alluvial soil, mainly silty soil. Red mud is the waste byproduct obtain from alumina industries, it is a solid waste generated after digestion of bauxite with NaoH at elevated temperature and pressure. Due to the presence of iron oxide and titanium dioxide, the colour of this waste turns red.

The soil stability problems such as design of foundation retaining walls, embankment, and knowledge of strength of the soil involved is very necessary. The Literature review suggested that Red mud finds its application in making bricks and cements and even in decontaminating mining sites (Amritphale and Patel 1987; Deng et al. 1980; Kohno et al., 1993; Kara and Emrullahoglu 1994; Singh et al., 1996). The geotechnical properties of red mud were studied by many researchers as to use it as an alternative material to soil (Li 1998; Newson et al. 2006; Sundaram and Gupta 2010; Rout et al. 2012; Sutar et al. 2014). Kalkan (2006) examined the hydraulic conductivity and swelling behavior of compacted clay liners with red mud and concluded that red mud is suitable for stabilizing clay liners. Kehagia (2014) studied the effect of fly ash on soil stabilized with red mud and found that more percentage of soil can be replaced with red mud when it is stabilized fly ash. Chemical stabilization of the soil using lime, cement, fly ash, and their combinations is very common nowadays. Among them lime is the most widely used admixture as they form cementing products which bonds the clay particles thereby reducing the plasticity, shrinkage, swelling and improve the strength characteristics (Bell 1988; Sherwood 199; Greaves 1996). Shallow

stabilization and deep stabilization using lime (Puppala et al., 2007; Rao and Shivananda, 2005; Rao and Thyagaraj, 2003) and in situ lime precipitation techniques (Thyagaraj et al., 2012; Thyagaraj and Zodinsanga, 2014) are currently being practiced in stabilizing weak clayey soils. Bhuvaneshwari et al. (2014) brought out the role played by lime modification optimum in soil-lime reactions which affected the physical properties as well as the structure of the lime stabilized soil. The present study involves experimental investigation to characterize red mud waste from HINDALCO, and to study its effect on compaction behaviour, and California Bearing ratio (CBR) of composite of alluvial soil with red mud mixtures. All the tests were performed in accordance with the procedures specified by Indian Standards.

2. PROPERTIES OF SOIL AND RED MUD CLAY

Alluvial soil and Red mud used in this study Table 1 was the following properties.

Table 1: Properties of Alluvial Soil and Red Mud

Alluvial Soil	Red mud
Grain size distributions Clay – 9 %, Silt – 77% Sand – 14%	Grain size distributions Clay – 12 %, Silt – 70% Sand – 18%
Specific gravity – 2.65,	Specific gravity – 2.98,
Optimum moisture content – 15%	Optimum moisture content – 22.5%
Maximum Dry density 1.84gm/cc	Maximum Dry density 1.77gm/cc
Atterberg's limit Liquid limit- 32.6%, Plastic Limit-20.6% Shrinkage Limit – 14.2% Plasticity Index- 12.0%	Atterberg's limit Liquid limit- 35%, Plastic Limit-30 % Shrinkage Limit – 24.8% Plasticity Index- 5.0%

3. ALLUVIAL SOIL – RED MUD MIXTURES

The test specimens were prepared by thoroughly mixing red mud with air dried alluvial soil sample in proportion varying from 4 to 20% by dry weight of soil. The following mixes at the increment of 4% were comprised to evaluate its behavior.

4. RESULTS AND DISCUSSION

4.1 Compaction Behavior:

Standard Proctor Compaction tests were conducted to study the effect of different percentages of red mud on compaction behavior of the alluvial soil. From Table 1 it can be seen that with increase in the percentage of red mud, Maximum Dry Density (MDD) was decreased from 1.84 g/cc to 1.72 g/cc and the optimum moisture content was increased up to 16% of red mud then there was decrease in the same.

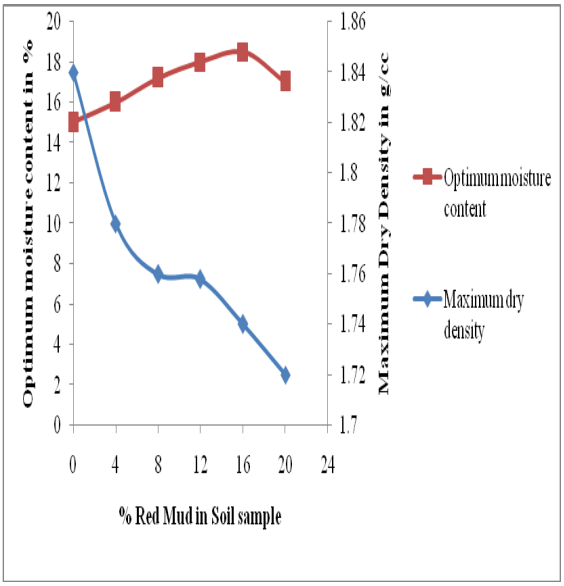

Figure 1: Percent of Red mud in soil sample verses O.M.C & M.D.D

4.2 CBR Value:

The variation in unsoaked and soaked CBR values with different percentages of red mud is shown in Figure 4. It can be seen that the CBR value increased till 16% of red mud and beyond which it decreased. Above this limit the soil became more plastic and finely

grained. Figure 4 Variation of CBR for untreated soil-RM mixes

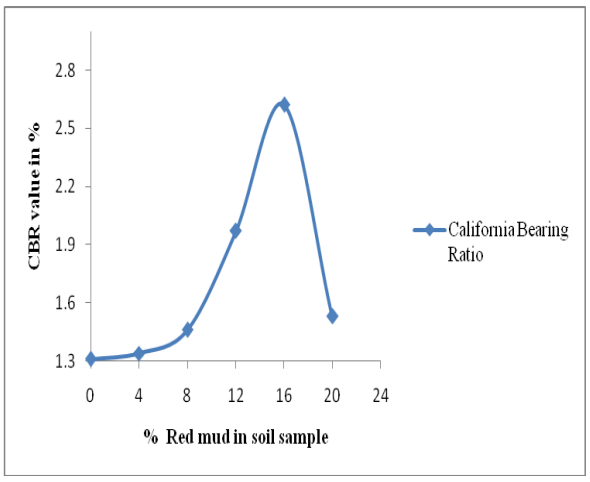

Figure 2: Variation of CBR for untreated soil-RM mixes

5. CONCLUSION:

For soil red mud mixture, as the percentage of red mud increases, maximum dry density decreases and optimum moisture content increases upto 16% addition of red mud and subsequently decreases.

The strength of soil in terms of California bearing ratio CBR (soaked) improved when the redmud is mixed with soil and optimum strength is obtained at 16% of red mud.

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