International Journal of Environmental Research and Development.
ISSN 2249-3131 Volume 4, Number 4 (2014), pp. 281-286

http://www.ripublication.com

Evaluation of Lime Stabilized Fly Ash as A Highway Material

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Abstract

Rapid growth of industrialization and large scale infrastructural development in India has resulted in scarcity of construction materials and unchecked increase in the environmental pollution. There is a thrust to investigate the feasibility of industrial waste materials to replace the conventional construction materials. Soil stabilization has been implemented for improving soils, which have inadequate engineering properties. This paper discusses the possibilities and ways of improving the strength properties of compacted flyash which is collected from the captive power plant of NSPCL-RSP stabilized with different percentages of lime. It describes a research that focus on the effect of lime content on compaction characteristics and CBR values of flyash subjected to different compactive energies. The CBR(California bearing ratio) values at both soaked and un-soaked conditions , (OMC) optimum moisture content and (MDD) maximum dry density of compacted fly ash mixed with 1%,2%,5% and 10% lime after different curing periods were evaluated, and is compared with properties of virgin fly ash.

Keywords: flyash, lime stabilization, CBR values, compaction characteristics.

1. Introduction:-

The design and construction of rural roads requires engineers to use the locally available soils for the pavement foundation. Pavement structures on poor soil sub grades show early distresses causing the premature failure of the pavement.

Stabilization of these types of soils using different additives is a usual practice as it becomes uneconomical to replace the foundation material with good quality soils. Industrial waste like fly ash can be effectively used in construction of highways and embankments, thus reducing environmental pollution. Flyash is a waste material from thermal power plants and shows pozzolanic characteristics. It is always encouraged to use flyash for stabilization where easily and economically available. Flyash is extracted from flue gases of a furnace fired with coal and is non-plastic in nature and is of silt to clay in size. Its composition varies according to the nature of coal burned. For increasing use of fly ash as a construction material, it is required to enhance some properties by stabilizing raw flyash with suitable stabilizers. Several researches on application of fly ash as bulk fill materials are available (DiGioia and Nuzzo 1972, Gray and Lin 1972, Glogowski et al. 1992, Kaniraj and Havanagi 2001, Kaniraj and Gayathri 2004). Soil stabilized and reclaimed with fly ash is reported by Chu et al. (1955), Goecker et al. (1956), Viskochil et al. (1957), Vasquez and Alonso (1981) and Kim and Chun (1994). Applications of fly ash alone or soil stabilized with flyash and admixtures for road construction have been reported by a number of researchers such as Manjesh et al. (2003), Reddy et al. (2004) and Ghosh and Subbarao (2006). Leonards and Bailey (1982) reported that the compacted pulverised coal ash, consisting of fly ash with varying percentages of bottom ash, had been used successfully as a structural fill material.

2. Material Used and Methodology:-

The materials used for this study are flyash and lime. Flyash used in this study was collected from the captive power plant (CPP-II) of Rourkela steel plant (RSP). The collected samples were mixed thoroughly to get the homogeneity and oven dried at the temperature of 105-110 degree. Similarly lime procured from the local market was powered, sieved through 150 micron sieve and stored in airtight container for subsequent use. Particle size distribution curve of flyash (Fig.1) shows that a major particle consists of silt size (86%) with coefficient of uniformity (Cu) and coefficient of curvature (Cc) for flyash were found to be 5.88 & 1.55 respectively. The specific gravity of flyash was determined according to IS: 2720 (Part-III) -1980 guidelines by Le-Chartelier method with kerosene oil. The specific gravity of the flyash and lime treated flyash used are 2.55, 2.56, 2.59, 2.6, & 2.66 respectively.

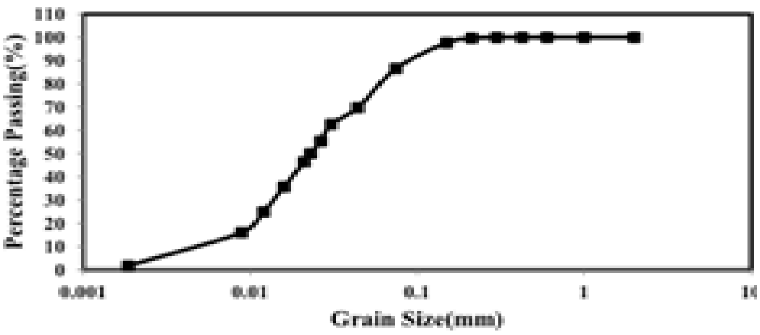

Fig.1. particle size distribution of flyash.

2.1. Moisture Content Dry Density Relationship:-

The compaction characteristics of fly ash was found by using compaction tests as per IS: 2720 (Part VII) -1980 and IS: 2720 (Part VIII)-1980.Fly ash was stabilized with varying percentage of lime. The lime content was 0%, 1%, 2%, 5%, and 10% of the dry weight of Fly ash. The moisture content of the compacted mixture was determined as per IS: 2720 (Part II) 1973. Similar compaction tests were conducted with varying compactive energy and the corresponding OMC and MDD were determined and presented in Fig 2. The compactive energies used in this test programme were 119, 356,593 and 2483 kJ/m3 of compacted volume.

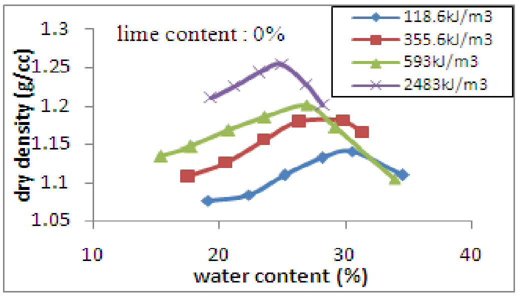

Fig.2.(a)

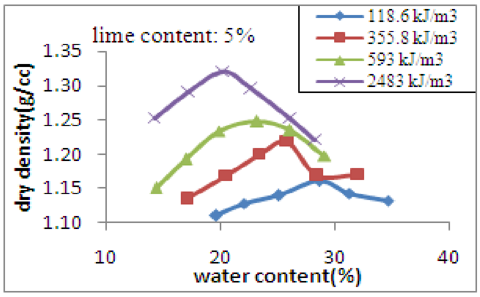

Fig.2.(b)

Fig.2.(a) & (b),Dry density vs Water content curve for flyash samples containing 0% & 5% lime respectively at different compaction energy.

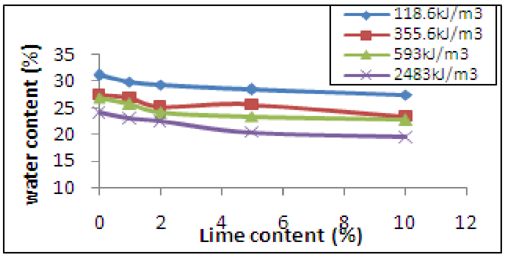

Fig.2.(c)

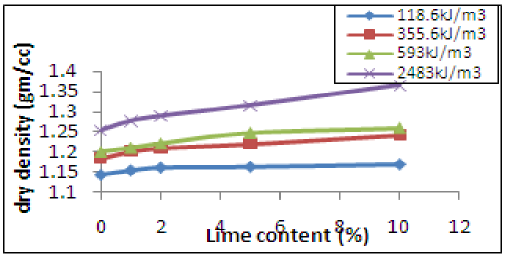

Fig.2.(d)

Fig.2(c). Variation of water content with flyash samples containing 0%,1%,2%,5% and 10% of lime & **Fig.2(d)** Variation of dry density with flyash samples containing 0%,1%,2%,5,10 of lime at different *compaction energy*.

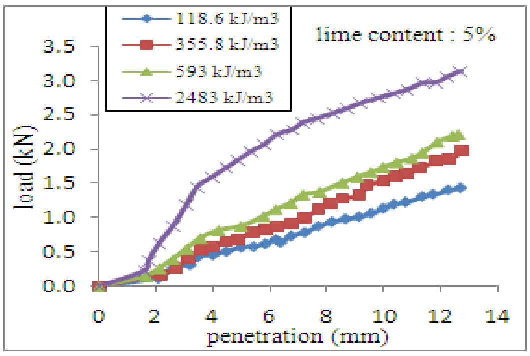

Fig.3. (a)

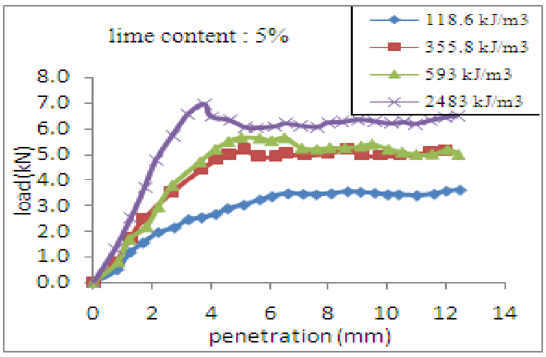

Fig.3. (b)

Fig.3. (a) & (b) Load Vs Penetration curve of flyash treated with 5% lime compacted at different compaction energy under soaked and unsoaked condition respectively.

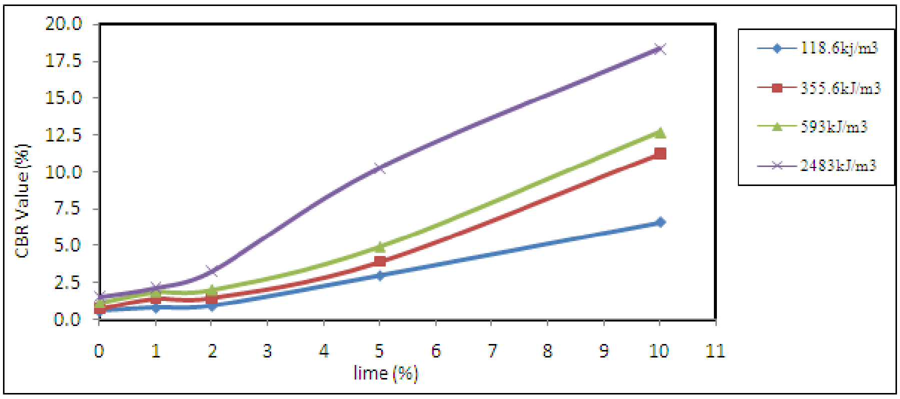

Fig.3.(c). Variation of soaked CBR with flyash samples containing 0%,1%,2%,5% and 10% of lime with varying compactive energies.

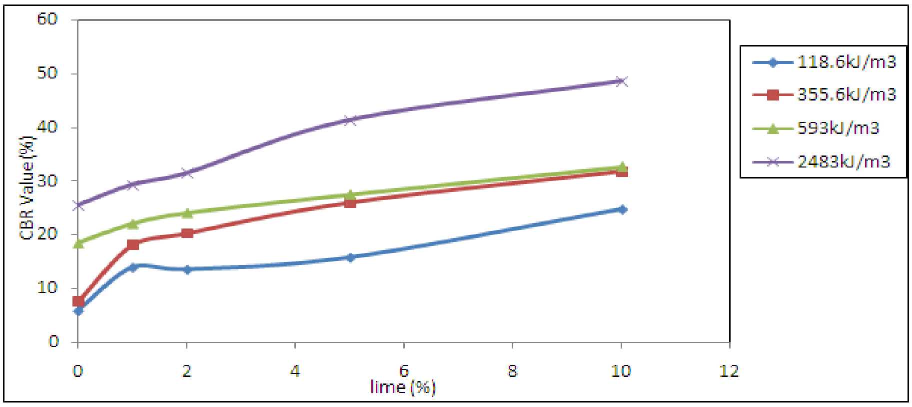

Fig.3.(d). Variation of unsoaked CBR with flyash samples containing 0%,1%,2%,5% and 10% of lime with varying compactive energies.

In both Fig.3. (c) & Fig.3.(d) it is visible that with increase in percentage of lime in the flyash, and the compactive energy, both soaked & unsoaked CBR values are increasing.

3. Conclusion

Dry unit weight of compacted specimens is found to change from 1.142 to 1.255 kJ/m3 with change in compaction energy from 118.6kJ/m3 to 2483 kJ/m3, whereas the OMC is found to decrease from 30.2 to 24.2 %. This shows that fly ash sample responds very poorly to the compaction energy. With addition of lime maximum dry density increases and optimum moisture content decreases. Addition of lime results in filling the voids of the compacted fly ash thus increases the density.The highest unsoaked and soaked CBR value are found to be 25.39% and 1.546% at compaction energy of 2483 kJ/m3.This indicates that CBR value of compacted ash is very susceptible to degree of saturation.The unsoaked CBR value is more than soaked CBR value.

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