ALTERNATIVE PAVEMENT COMPOSITION FOR SERVICE ROAD WITH POND ASH LIME STABILISED LAYER

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INTRODUCTION

In this paper an attempt is made to present a brief review of the relevant literature on the Pond ash alone and Pond ash Lime stabilized layer in the flexible pavement construction instead of conventional sub-base and base layer.

Coal ash is a waste product of coal combination in thermal power plants. It possess problem for the safe disposal and cause economic loss to the power plants. Thus, utilization of coal ash in large scale geotechnical constructions as a replacement to conventional earth material needs special attention. The inherent strength of coal ash can be improved either by stabilizing the material with cement, Lime etc. and by reinforcing the same.

Pond ash is the product of combination of fly ash and bottom ash and is by-products of thermal power plants. Together these are mixed with water to form slurry. That slurry is pumped to the ash Pond. In ash Pond area, excess water is removed and the ash settles as reside. This residual deposit is called Pond ash. This is used as filling materials including in the construction of roads & embankments. Selected Pond ash is used for manufacturer of building products like Lime fly ash bricks/ blocks etc.

Among the industries thermal power plants are the major contributor of Pond ash. Besides, this steel, copper and aluminium plants also contribute the substantial amount of Pond ash

LITERATURE REVIEW

Bera et al. (2007) presented the study on compaction characteristics of Pond ash. Three different types of Pond ash have been used in this study. The effects of different compaction controlling parameters, viz. Compaction energy, moisture content, layer thickness, tank size, and specific gravity on dry density of Pond ash are highlighted herein. The maximum dry density and optimum moisture content of Pond ash vary within the range of 8.40-12.25 KN/m3 and 29-46% respectively. In the present investigation, the degree of saturation at optimum moisture content of Pond ash has been found to vary within the range of 63-89%. An empirical model has been developed to estimate dry density of Pond ash, using multiple regression analyses, in terms of compaction energy, moisture content, and specific gravity. Linear empirical models have also been developed to estimate maximum dry density and optimum moisture content in the field at any compaction energy. These empirical models may be helpful for the practicing engineers in the field for planning the field compaction control and for preliminary estimation of Maximum Dry Density and Optimum Moisture Content of Pond ash.

Chand et al. (2007) presented the effects of Lime stabilization on the strength and durability aspects of a class F pond ash, with a Lime constituent as low as 1.12%, are reported. Lime contents of 10 and 14% were used, and the samples were cured at ambient temperature of around 30°C for curing periods of 28, 45, 90, and 180 days. Samples were subjected to unconfined compression tests as well as tests that are usually applied to rocks such as point load strength tests, rebound hammer tests, and slake durability tests. Unconfined compressive strength (UCS) values of 4.8 and 5.8 MPa and slake durability indices of 98 and 99% were achieved after 180 days of curing for samples stabilized with 10 and 14% Lime, respectively. Good correlations, that are particularly suitable for stabilizing materials of low density and low strength, have been derived from strength parameters obtained from UCS tests, point load strength tests, and Schmidt rebound hammer tests, and also between UCS and slake durability index.

Ghosh et al. (2010) presents the laboratory test results of a Class F Pond ash alone and stabilized with varying percentages of Lime (4, 6, and 10%) and PG (0.5, and 1.0), to study the suitability of stabilized Pond ash for road base and sub-base construction. Standard and modified Proctor compaction tests have been conducted to reveal the compaction characteristics of the stabilized Pond ash. Bearing ratio tests have been conducted on specimens, compacted at maximum dry density and optimum moisture content obtained from standard Proctor compaction tests, cured for 7, 28, and 45 days. Both un-soaked and soaked bearing ratio tests have been conducted. This paper highlights the influence of Lime content, PG content, and curing period on the bearing ratio of stabilized Pond ash. The empirical model has been developed to estimate the bearing ratio for the stabilized mixes through multiple regression analysis. The linear empirical relationship has been presented herein to estimate soaked bearing ratio from un-soaked bearing ratio of stabilized Pond ash. The experimental results indicate that Pond ash-Lime-PG mixes have potential for applications as road base and sub base materials.

Jakka et al. (2010) studied carried on the strength and other geotechnical characteristics of Pond ash samples, collected from inflow and outflow points of two ash ponds in India, are presented. Strength characteristics were investigated using consolidated drained (CD) and undrained (CU) triaxial tests with pore water pressure measurements, conducted on loose and compacted specimens of Pond ash samples under different confining pressures. Ash samples from inflow point exhibited behaviour similar to sandy soils in many respects. They exhibited higher strengths than reference material (Yamuna sand), though their specific gravity and compacted maximum dry densities are significantly lower than sands. Ash samples from outflow point exhibited significant differences in their properties and values, compared to samples from inflow point. The shear strength of the ash samples from outflow point are observed to below, particularly in a loose state where static liquefaction is observed.

M.V.S. Sreedhar et al (2011) Presents coal ashes is need for increasing the utilization. Pond ash being a non-plastic cohesion less material has potential to be used as an overlay. However, the "fly by air" nature of the Pond ash is to be controlled by stabilisation. In view of this, efforts are made in this project to stabilise the Pond ash with Lime in various substitution levels 2%, 5%, 10% and 20%. The effect of Lime on compaction and CBR characteristics are observed systematically including the role of curing period. For the materials used in this research when Pond ash was substituted by 20% of Lime and cured for 28 days, the CBR value was found to be 156%. This study brings out the promising performance of Lime stabilised Pond ash as an overlay.

Raju Sarkar et al. (2013) Presents Pond ash is a pozzolanic material and can be stabilized with Lime. It can also be stabilized with other commonly available stabilizers like cement, bentonite etc. This paper deals with both geotechnical characteristics of the Pond ashes alone as collected from various thermal power stations in the National Capital Region, Delhi and also when they are stabilized using Lime. The purpose of mixing this additive with Pond ash is to improve the strength, deformability, volume stability (shrinking and swelling), permeability, erodibility, durability etc. of the mix for their use in the road construction.

Barkha Tripathi et al. (2013) Presents Recycling of waste material is one of the effective solutions of its disposal problem. Fly ash generated by coal-based thermal power plant takes huge amount of land for disposal and creates environmental problem. From each power station, thousands of tons of fly ash are pumped in to the ash ponds in the form of slurry. Solidification/stabilization of fly ash improves the geotechnical properties and reduces the adverse effect to the environment. This paper shows the laboratory test results of Class C Pond ash mixed with small amount of Lime, and local soil. In the present investigation, various tests were conducted on soil sample mixed with various percentages of fly ash and Lime. The result reveals that the optimum content of admixture for achieving maximum strength is approximately 92% Pond ash mixed with 3% Lime. Scanning Electron Microscope imageries were also confirmed that change in structure due to stabilization.

EXPERIMENTAL STUDY

Selection of Pond ash for stabilization

To ascertain the strength parameters of stabilized Pond ash, laboratory investigations are carried out on Pond ash collected from Kakathiya Thermal Power

Plant at Bhupalapally in Warangal District as shown in Figure.

CBR TEST
[Test Method IS 2720 (Part - 16)]

PRC Sample Ref. No.	:	Date Received	:10.1.14
Description of Sample	**: Pond ash+10%Lime**	Date tested	:17.1.14
Source of Sample	: Bhupalapalli	Location/Chainage	: ash pond
Type of Curing	**: Oven Cured at 7 days @ 40^0 C temperature**	Proving Ring Reading, 1Div.=	**9.53**

LOAD IN PENETRATION TEST DATA

General information		Penetration in (mm)	Mould No.2		
			Proving Ring Reading	Applied Load on Specimen	% of CBR
Wt. of surcharge : 5 Kg		0.5	19.0	181.07	
		1.0	37.0	352.61	
Penetration in mm	Standard Load	1.5	55.0	524.15	
	(Kgf)	2.0	72.0	686.16	
2.5	**1370**	**2.5**	89.0	848.17	**61.90**
		3.0	106.0	1010.18	
		4.0	122.0	1162.66	
5.0	**2055**	**5.0**	144.0	1372.32	**66.80**
		7.5	172.0	1639.16	
		10.0	203.0	1934.59	
		12.5	236.0	2249.08	
Avg CBR %			**64.3**		

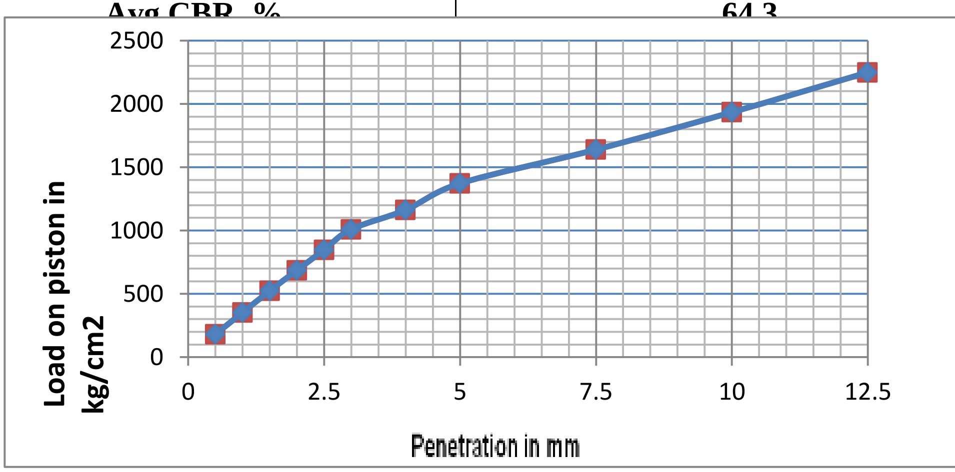

Figure: Pond ash

Lime stabilization is done by adding Lime to a Pond ash. Lime act as a binder for the stabilization of sub-base and base course layers for all road pavements. When the addition of Lime in the Pond ash, the maximum dry density increases up to certain value and decreases thereafter. The increase in the strength due to Lime stabilization confirms the pozzolanic nature of the ash, and this its capability to react with Lime and develop substantial strength. The resulting material is more friable than the original Pond ash, and is, therefore, more suitable as sub-base and base layers.

The Lime used in the present study was procured from the open market in the form of quick Lime. This Lime was then mixed with Pond ash and water in required proportion by weight.

Figure: Lime Stabilizer

Tests on Pond ash

Prior to the tests on Pond ash and Lime stabilized Pond ash, the basic tests such as wet sieve analysis, Liquid Limit (LL) and Plastic Limit (PL), modified proctor compaction to find Optimum Moisture Content (OMC) and Maximum Dry density (MDD), Unconfined Compressive Strength (UCS) and California Bearing Ratio (CBR) tests were conducted. All the tests are conducted as per the Indian standard specifications. These tests were used for identifying the type of Pond ash, its plasticity characteristics and to find the UCS & CBR values (soaked and unsoaked) of Pond ash. Results of tests conducted on Pond ash are presented in the Table below.

Table: UCS Values for Lime stabilized Pond ash

WET AND DRY TEST [As per IS 4332 (Part - 4)]					
Type of material		**Pondash+10% Lime**			
Source :					
Cycle No	**Sample No:**	**Date of Testing**	**Wt. of Dry Sample (gr)**	**% wt of Loss**	**Remarks**
I	G	04.02.14	1624	-	
	H		1623	-	
II	G	06.02.14	1598	1.60	
	H		1597	1.60	
III	G	10.02.14	1580	2.71	
	H		1578	2.77	
IV	G	12.02.14	1566	3.57	
	H		1569	3.33	
V	G	14.02.14	1558	4.06	
	H		1560	3.88	
VI	G	18.02.14	1550	4.56	
	H		1553	4.31	
VII	G	20.02.14	1543	4.99	
	H		1545	4.81	
VIII	G	24.02.14	1536	5.42	
	H		1538	5.24	
IX	G	26.02.14	1529	5.85	
	H		1531	5.67	
X	G	28.02.14	1523	6.22	
	H		1526	5.98	
XI	G	03.03.14	1517	6.59	
	H		1519	6.41	
XII	G	05.03.14	1511	6.96	
	H		1513	6.78	
	Avg. % wt. of Loss after 12th cycle (%)			**6.87**	

RESULTS AND DISCUSSIONS

The experiments performed on Pond ash Lime stabilized layer are explained in detail.

In this paper analysis of results were discussed.

Pond ash was sieved on a set of standard sieves like soils. Classification systems are used to group soils according to their order of performance under given set of physical conditions. They are grouped in order of performance for one set of physical conditions will not necessarily have the same order of performance under some other physical conditions. Indian Standard Classification System (IS: 1498-1970) was adopted by Bureau of Indian Standards are in many respect similar to the Unified Soil Classification (USC) System. Soils are divided into three broad divisions based on the percentage of material passing through various sieves.

- Coarse grained soils, when 50% or more of the total material by weight is retained on 75 micron sieve.
- For fine grained soils, when more than 50% of the total material passes through 75 micron IS sieve.
- If the soil is highly organic and contains a large percentage of organic matter and particles of decomposed vegetation, it is marked as peat (Pt). Generally possible in forest areas.

To know the distribution of particle size, wet analysis was conducted. Sieve analysis result reveals that more than 65% of the materials are in the range of 0.075mm and 4.75 which are mainly sand.

Optimum Moisture Content (OMC) and MDD

OMC is determined by deducting the percentage of Lime from the Pond ash Optimum Moisture Content. MDD for various percentages of Lime stabilized Pond ash are shown the in the Figure below.

It is observed from the Figure that the Maximum Dry Density (MDD) values for the Lime stabilized Pond ash are decreasing sligtly with the increasing in percentage of stabilizers. This is mainy due to lubricating of soil particles due to the Lime stabilizer. In general, MDD values will be determined in the laboaratory with in the short period of time and the influence of Lime cannot be known. Curing of Lime specimens will give the proper results.

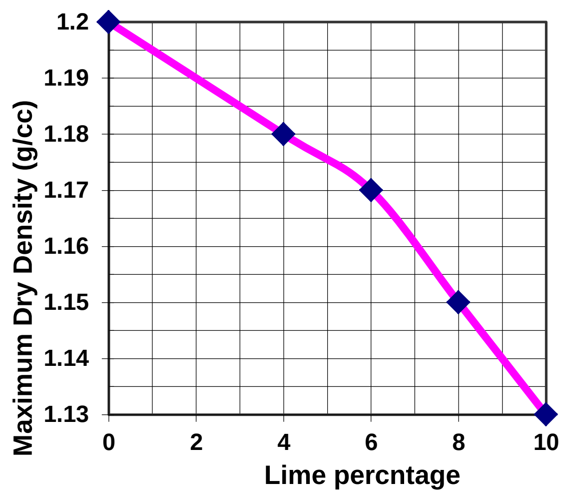

Figure: MDD values for the stabilized Pond ash having various percentage of Lime

It is observed from the Figure that the Optimum Moisture Content (OMC) values for the Lime stabilized Pond ash are incresing sligtly with the increasing in percentage of stabilizers.

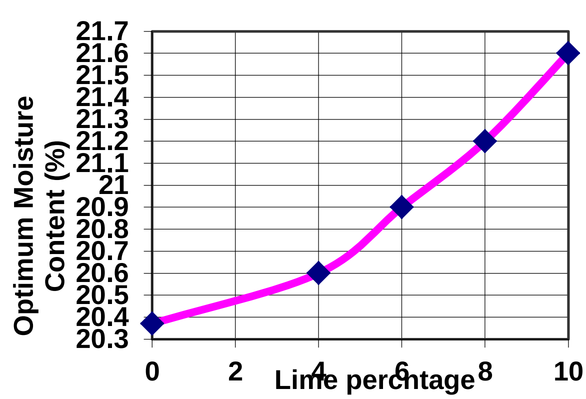

Fig: OMC for the stabilized Pond ash having various percentage of Lime

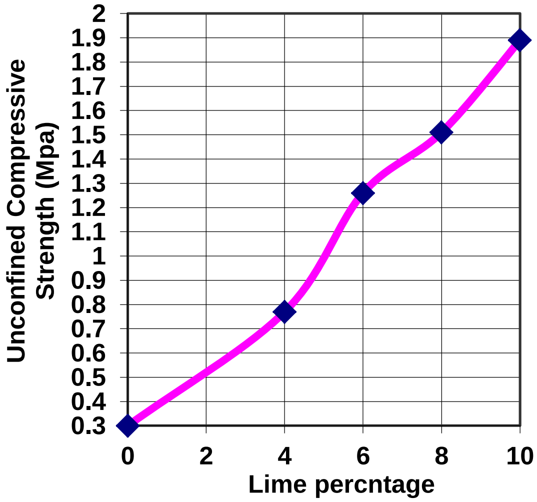

Figure: UCS values for the stabilized Pond ash having various percentage of Lime

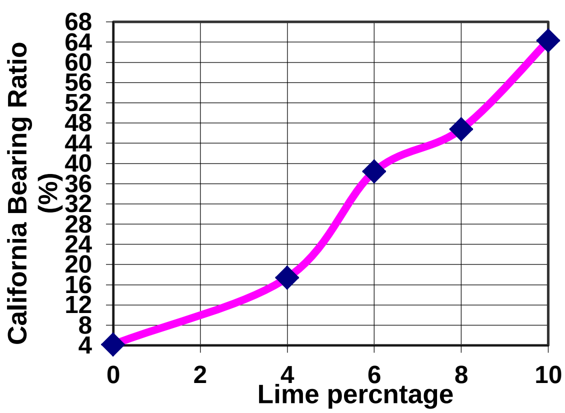

Figure: CBR values for the stabilized Pond ash having various percentage of Lime

CONCLUSIONS

Based on the results of the investigation conducted on different mixes of Pond ash with varying percentages of Lime, the following conclusions can be drawn:

- UCS and CBR values are significantly increased for Lime stabilized Pond ash as compared to the Pond ash values.
- Loss of weight in wetting and drying is more for low percentage of stabilizer and low for the high percentage of stabilizer. Since the percentage of loss is within 14% as per IRC SP 89: 2010, 6% of Lime stabilized Pond ash is considered as optimum dosage for stabilization (based on the laboratory test results).
- Based on the UCS value for 6% Lime stabilised Pond ash, the obtained elastic modulus is more than 1200 MPa for the Pond ash. However, considering the enough factor of safety a value of 600Mpa was used in the analysis.
- The alternative pavement composition is without DBM layer and a thin surface course layer. Due to this fatigue failure is not considered.
- Total savings due to alternative pavement composition is more than 30% as compare to the conventional pavement composition.
- In the alternative pavement, huge quantity of aggregates saved by eliminating the granular base (WMM) and bituminous base (DBM) layers.

FUTURE SCOPE OF THE WORK

Based on the results of the investigation conducted on different mixes of Pond ash with varying percentages i.e. 4%, 6%, 8% and 10% of Lime, the following recommendations were made for the future scope of the project:

- Laboratory investigations conducted to check the increasing in strength of the stabilized Pond ash with the addition of Lime stabilizer. To check the field performance, small length of the road can be constructed by consulting with the contractors.

- In the present case Pond ash is considered for stabilization and Pond ash is a non plastic material. Possibility of increasing in strength for other source of Pond ash can be explored.

- The other stabilizations like Pond ash cement stabilization, Pond ash Lime, local soil stabilization and Pond ash Lime Phosphogypsum stabilization can be conducted to check the increase in strength of such stabilized layers.

- Stabilization by nonconventional stabilizers such as RBI grade-81, Soil Tech and TerraZyme etc. can be conducted to check the increase in strength of the stabilized layers.

- Possibility of alternative pavement composition for Main Carriageway at least for 30 MSA traffic can be explored.

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