Research Paper

Volume : 4 | Issue : 6 | June 2015 • ISSN No 2277 - 8179

Performance Analysis of Pond ASH as Partial Replacement to Black Cotton Soil for Pavement Subgrade Construction

Engineering

KEYWORDS : Black cotton soil, Pond Ash, Soil Stabilization, CBR Value

Girish Dinkar Patil — P.G.Scholar, Department of Civil Engineering, Rajarambapu Institute of Technology, Islampur, Maharashtra,India

Sushma Shekhar Kulkarni — Director, Rajarambapu Institute of Technology, Islampur, Maharashtra, India

ABSTRACT

Expansive nature of black cotton soil generates lot many problems in pavement construction. It drastically affects the performance and life of the pavement. Thus for good performance and long life of road it is important to improve the properties of black cotton soil. This study deals with improving the properties of black cotton soil through addition of Pond ash as industrial waste. Laboratory tests were conducted on various proportions of mixes of black cotton soil and industrial wastes 0% to 25% at the interval of 5%. The soaked CBR value of untreated soil is 0.61%. The soaked CBR value of mix soil: Pond Ash in the proportion of 80:20 is 1.53% which is increased by 92% in comparison with untreated soil. Where Stabilized pavement is designed by using industrial waste in the sub-grade the total thickness of pavement is decreased by 150 mm, as comparison with conventional flexible pavement.

1. Introduction

Black cotton soil causes many problems to road constructed on it. About 20% of the soil found in India is expansive in nature. Roads on black cotton soils are known for bad condition. In rainy season black cotton soil absorbs water heavily which results into swelling and softening of soil. In addition to this it also loses its strength and becomes easily compressible. Black cotton soil has tendency to heave during wet condition. In summer season due to reduction in water content it shrinks and produces cracks. Thus as a result of this roads on black cotton soil suffer from early failures in pavement with heavy traffic excessive unevenness, ruts, waves and corrugations are formed. It is proposed to study causes of roads failure on black cotton soil. Typical behavior of these soils under different climatic conditions has made the construction and maintenance of road not only expensive but also difficult. The failure occurs after every monsoon season, resulting in heavy cost of maintenance demand every year. The black cotton soils are very poor and undependable subgrade material. Hence the main problem is to treat the subgrade soil itself such that the undesirable characteristics are modified by stabilization. Stabilization is the process of improving the engineering properties of soil and making it more stable. Now days there is problem of utilization of industrial waste because thousands of tones wastes are generated from industry. The usage of industrial waste in stabilization of soil becomes economical and it is easily available. In this study, industrial waste like Pond Ash used to improve geotechnical properties of a soil.

2. Research Design

The problems related to road construction on black cotton soil is minimized in this work, the design of experiment is as follows

A. Step I

The sample of black cotton soil was collected from 6 laning of NH4 Peth Naka,Dist- Sangli, Maharashtra. Various laboratory tests carried out on soil to determine the properties of black cotton soil.

B. Step II

Pond Ash is industrial waste used to improve the properties of black cotton soil from 0 to 25% proportions independently

C. Step III

Based on the soaked CBR values of mixes determine the optimum content of stabilizer. As per IRC 37 CBR test is important because CBR value is directly related to pavement thickness.

D. Step IV

Design of conventional flexible road and stabilized road is done by using IRC 37.This design is based on CBR method.

3. Objective of study

A. To study the physical & engineering properties of black cotton soil by conducting Laboratory tests mainly consistency limit, Atterberg limit, standard proctor test & CBR value.
B. To study the physical & engineering properties of Pond Ash.
C. To study the change in properties of black cotton soil by adding pond ash.
D. To find the optimum amount of stabilizer (pond ash) required for stabilization of black cotton soil.

4. Materials Used For the Study:

A. Soil

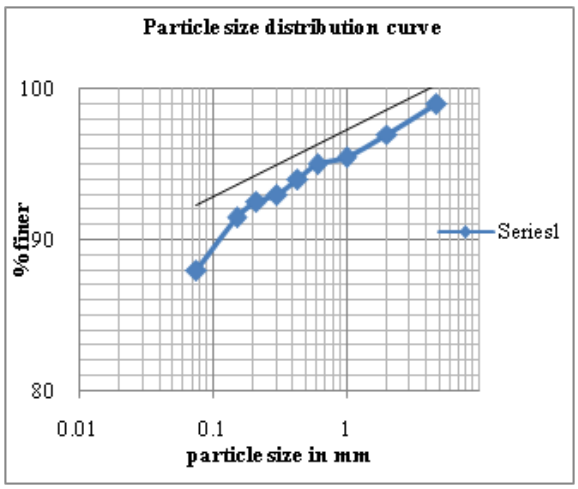
The soil use for this study is collected from 6 laning of NH4 Peth Naka, Dist- Sangli, Maharashtra. This soil has black-grey color. The index properties such as liquid limit plastic limit, plasticity index and other important soil properties as IS 2720 and soil classification systems are presented in Table 1.

Table 1 Basic properties of Black Cotton Soil

Properties	Sample1
Type of soil	Black cotton soil
Colour	Black
Specific Gravity	2.43
Grain size distribution; Coarse sand (%) Medium sand (%) Fine sand (%) Silt and clay (%)	 0.6 3.1 7 89.3
Atterbergs limit; Liquid limit, LL (%) Plastic limit, PL (%) Plasticity index, PI (%)	 49 36.86 12.14
IS Classification	MI
Compaction Characteristics Maximum dry density (gm./cm^3) Optimum moisture content (%)	 1.29 26.6

The particle size distribution graph of black cotton soil shows that the soil is poorly graded.

Graph 1Particle size distribution curve for Black cotton soil



The graph is between 88 % to 100 % finer. The % Finer is more hence clay and silt content are high.

From the test result it is identified that black cotton soil contains 10.7 % of sand particles and 89.3% of silt& clay particles. Due to more % of silt & clay black cotton soil is very weak.

B. Pond Ash

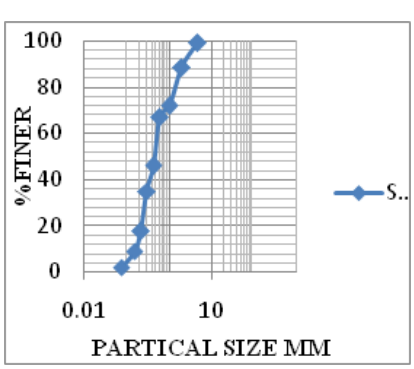
Pond ash is industrial waste of Thermal power plant. The pond ash used in this work was obtained from Jaygad power plant. The properties of Pond ash are in table 2.

Table 2 Properties of Pond ash

Sr.No	Physical parameters	Value
1	Colour	Gray
2	Specific gravity	1.87
3	Liquid limit	Non plastic
4	Plastic limit	Non plastic
5	Optimum Moisture content %	18
6	Maximum Dry Density (g/cc)	1.46
7	California bearing ratio (%)	2.96

The particle size distribution graph of Pond Ash shows that the soil is well graded because uniform size particles are present in soil.

Graph 2 Particle size distribution curve for Pond Ash



From the test result of Pond ash, the following identification are made,

The grain size distribution of Pond ash shows that it consists of 98% of sand particles and 2% of silt particles. Majority of Pond ash particles are medium to fine sand ranges with rough texture. Compaction characteristics of Pond ash under standard proctor test have an optimum moisture content 18% and maximum dry density 1.46 g/cc.

5. Experimental Investigations:

A. Compaction Test (Standard Proctor Test):

Optimum Moisture Content (OMC) as determine by standard procter test. Pond Ash is added in black cotton soil in 10%, 15%, 20%,25% by weight. For this samples the compaction test are carried out. From this the relation between the water content and dry density is find out. Result are shown in Table 3

Table 3 Standard proctor test values after addition of Pond Ash.

% Of Addition	Maximum Dry Density(gm/cc)	Optimum Moisture Content(%)
Untreated Soil	1.29	26.6
10%	1.37	21.5
15%	1.35	23.64
20%	1.28	25.33
25%	1.25	27.66

This method covers the determination of the relationship between moisture content and the density of soil compacted in a mould of given size. This test is required to find out the amount of compaction and water content required on field.

B.CBR Test:

After standard procter test, CBR test were performed on given proportions of soil and pond ash. The Unsoaked and soaked CBR tests were carried out. CBR test were most important test because as per IRC 37 the pavement thickness is depends upon CBR value of soil. The values obtained are shown in table 4.

Table 4 CBR test values after addition of Pond Ash

% Addition	CBR %	
	Unsoaked	Soaked
Untreated	0.91	0.61
10%	1.73	1.02
15%	2.24	1.32
20%	2.86	1.53
25%	2.14	1.32

Volume : 4 | Issue : 6 | June 2015 • ISSN No 2277 - 8179

All results obtained from the tests shows the changes in properties of black cotton soil after addition of various percentages of waste as Pond ash. The gradation of soil is changes after addition Pond ash due to which gap between soil particles is reduced. The soil particles comes closer to each other & compact effectively due to which CBR value of soil increases, result in to stability of soil increases. After addition of Pond ash up to 20 % CBR value goes on increasing, after that with further addition of Pond ash the value of CBR goes on decreasing due to change in gradation of soil particles.

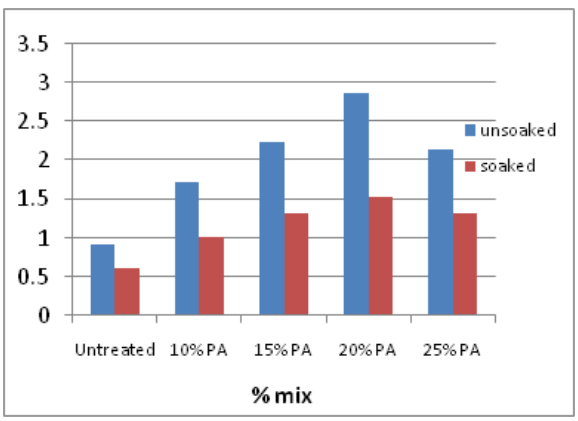


Fig 2 Comparison of soaked and Unsoaked CBR of (Black Cotton soil + Pond Ash)

The chart shows that CBR value is high, when 20% Pond Ash is added with black cotton soil. The value of CBR for 20% is 2.86 and 1.53 respectively for Unsoaked and soake.

6. Thickness Design

In order to design a flexible pavement IRC: 37 – 2001 is used in which the evaluation of factors (design traffic, vehicle damage factor, design life, etc.) are considered for National highway. Thickness design for untreated soil, treated with Pond Ash is carried out. The data for pavement design are assumed for National highway which are given below and from that thickness design of flexible pavement is worked out. Data considered for design of pavement is given below.

1. 6 lane divided carriageway
2. Initial traffic in each direction in the year of completion of construction = A =5600CV/day.
3. Design life = n = 15years.
4. CBR of sub grade soil = 0.61 ≈ 1.0
5. The traffic growth rate = r =8%
6. Vehicle damage factor = f = 4.5
7. Distribution factor =D = 0.6

$$N = \frac{[365\times(1+r)^n - 1]}{r} \times A \times D \times F$$

$$N = \frac{[365\times(1+0.08)^{15} - 1]}{0.08} \times 5600 \times 0.60 \times 4.5$$

$$N = 149847086.3$$

$$N \approx 150 \text{ msa}$$

Cumulative standard axels N= 150 is taken in to consideration according to IRC 37 total pavement thickness is of 975mm. CBR value of untreated soil ≈1. If CBR value is less than 2%, we want to add capping layer of 150mm according to IRC 37.

B. Composition of pavement for untreated soil from plate (IRC37 p.g.No. 29)

1. Bituminous surfacing = 50mm
2. DBM = 215m
3. Base = 250mm
4. Sub-base = 460mm
5. Capping layer = 150mm

C. Composition of pavement for treated soil from plate (IRC 37 p.g.No. 29)

For untreated soil treated with Pond Ash having CBR=1.53≈2 % corresponding thickness design is worked out as per IRC: 37.

1. Bituminous surfacing = 50mm
2. DBM = 215mm
3. Base = 250mm
4. Sub-base = 460mm

D.Comparison of Thickness of Natural & Treated Layer:

Table 5 Comparison of un-treated & Treated Layer

Layer	Untreated soil	Treated soil
Bituminous surface	50mm	50mm
DBM	215mm	215mm
Base	250mm	250mm
Sub –base	460mm	460mm
Capping layer	150mm	-
Total Thickness	1125mm	975mm

From above pavement design due to increase in the CBR value of sub-grade total thickness of pavement is decreased by 150mm.

7. Conclusion:

Based on the test results, the following conclusions have been drawn:

7.1 The black cotton soil considered for project have been tested and found that properties of soil are not favorable for construction of road because CBR value of soil is less than 2%.

7.2 The locally available black cotton soil properties have been improved by adding 20% Pond Ash.

7.3 The CBR value of black cotton soil is increased after addition of the pond ash; initially it is 0.61% and after addition of 20%pond ash CBR value is increased up to 1.53%.

7.4 After addition of Pond ash up to 20% CBR value goes on increasing, after that with further addition of Pond ash the value of CBR goes on decreasing due to change in gradation of soil particles.

7.5 From pavement design due to increased in the CBR value of sub-grade total thickness of pavement is decreased by 150mm.

REFERENCE

Dr. K.V. Krishna Reddy,(April,2013), Benefit Analysis of Subgrade and sub Surface Improvements in Flexible Pavements ISSN 0976 volume 4,issue 2,pp 385-392. | | P.V.V.Satyanarayana, N.Pradeep&et.al. A Study on the Performance of Pond Ash In Place of Sand and Red Soil as A Subgrade and Fill Material"ISSN:2249-8958,volume-,Issue-I,2013 | U. D. Hakari, S. C. Puranik,Stabilisation of Black Cotton Soils Using Fly Ash, Hubballi-Dharwad Municipal Corporation Area, Karnataka, India Global Journal of researches in engineering Civil And Structural engineering, volume 12 Issue 2 Version | | Roy T.K., Chattopadhyay B.C., Utilization of Rice Husk Ash and Pond Ash fo improving subgrade in road construction, Institution of Engineers (I) Civil engineering journal, January-2008. | Mukesh A. Patel, Dr. H. S. Patel, A Review on Effects of Stabilizing Agents for Stabilization weak Soil, Civil and Environmental Research Vol 2, No.6, 2012 | | K. S. Gandhi, Stabilization of Expansive Soil of Surat Region using Rice Husk Ash & Marble Dust, International Journal of Current Engineering and Technology, October 2013, Vol.3, No.4, pp. 1516-1521. | | Indian Standard-IS: 2720 (Part 3,4,5,7); Methods of test for soils. New Delhi, India. | | IRC 37 (2001); Guidelines for the design of flexible pavement. | | Dr.B.C Punmia, Ashok Kumar Jain and Arun Kumar Jain (2008). "Soil Mechanics and Foundation". Laxmi Publications Pvt. Ltd. New Delhi. |