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"Evaluation of the Properties of Expansive Soil Using Pond Ash and Polypropylene Fiber"

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Abstract
An experimental work was undertaken to investigate the effects of discrete short polypropylene fiber (PP-fiber), on the strength and mechanical behavior of black cotton soil(BCS). This project deals with use of pondash(PA) and (PP-fiber), for improvement in CBR value of clayey and silty soil. The tests like Maximum Dry Density (MDD), Optimum Moisture Content (OMC), California bearing ratio (CBR),Dynamic cone penetration (DCP)and unconfined compressive strength(UCS) test were done on the soil in the laboratory for various percentages of 0.15% and 0.3%along with 10%,20% and 30% pond ash. In the present investigation a series of laboratory tests has been performed to know the effect of pond ash content on engineering properties of soil. From the experimental results it is found that with increase in percentage of pond ash (with in the range of 0 to 30 %) in the soil, the liquid limit of the soil pond ash mixture decreases gradually.

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I. INTRODUCTION

1.1: In India more than 20% of soil cost expansive. When roads are made up of on black cotton soil, it may cause many problems. Hence in many places making of roads will use black cotton soil (BCS). But this BCS causes some problems during rainy seasons, the water absorption will be more which insist in swelling and shrinkage. Due to this, it loses its strength. During summer season water get evaporates and it shrinks which causes cracks. Hence it may not suitable both in rainy and summer seasons. The BCS are very inferior and unreliable sub grade material. In order to reduce the problems from black cotton soil, the sub grade soil can be modified by proper improvement. Stabilization is the process of improving the mechanical properties of soil. For soil stabilization, we can adopt mechanical or chemical techniques both technique required skilled man and also requires huge machineries to get good results. uniformly spreaded fiber when used as stabilizer in highway as sub grade material can make a high successive stabilized sub grade. Many investigators have done work on different fibers under various condition. The most important findings in research work is that the use of certain fiber such as synthetic and having good ductile property, which mainly ment for road work can significantly increase pavement resistance to rutting, as compared to the resistance of non-stabilized pavement over a weak sub grade.

OBJECTIVE

- To know the physical & engineering properties of black cotton soil by conducting Laboratory tests mainly consistency limit, Atterberg limit, standard proctor test & CBR value.
- To study the change in behavior of BCS by adding pond ash and polypropylene fibers mixes in terms of CBR value and UCS.

II. MATERIALS AND METHODOLOGY

MATERIALS USED FOR THE STUDY:

- **SOIL**

The soil sample used is obtained from kousika village of Hassan district. This soil has black-grey color.

- **POND ASH;**

(FIG.1) POND ASH

Pondash is by- product of Thermal power plants. The pond ash used in this project is brought from Raichur thermal plant.
Pond ash is a combine of dry fly ash and bottom ash. During the years 2010-12, about 408 Million tonnes/year of coal was used and over 130 Million tonnes/year of fly ash was generated by 88 thermal power plants all over India. Pond ash contributes to two major environmental problems: generation of respirable particulate matter (a major air pollutant) and pollution of soil and water due to leaching of heavy metals.

Table 1.1 Physical properties of pond ash

Colour	**Grey**
Specific gravity	**1.72**
Fines modulus	**2.52**
Bulk density(kg/m^3)	**818**

Table 1.2: CHEMICAL properties OF POND ASH

Composition	**RTPS Raichur sample**
aluminium oxide (Al2O3)+ iron oxide (Fe203)+ Silicon dioxide (Si02), percent by mass.	**93.70**
Silicon dioxide (Si02),	**60.08**
Magnesium oxide (MgO),	**0.71**
Total sulphur as sulphur trioxide (SO3),.	**0.40**
Loss of Ignition, percent by mass.	**2.60**

- **POLYPROPYLENE FIBER**

Polypropylene fibers are getting popularity in construction industry because of its good advantageous properties.earlier these fibers were only utilized in concrete. But now a days it is being used in highway work for sub grade improvement. These fibers improve the strength ad ductility of soil. The fibers aspect ratio and other properties plays a greater role in selection . these fibers for mainly used in clay silt and other weak soils. physical properties.

Table 3.3: PROPERTIES OF FIBER

Property	Value
Cutting length	6mm or 12mm
Shape of fiber	Special for holding cement aggregate
Tensile strength	4000-6000kg/cm2
Melting point	>250 centigrade
Colour	White
Unit weight	0.91g/cm3
Average diameter	0.034mm
elasticity	3500mpa
Burning point	590^0C
Dispensability	Excellent

(FIG.3.1b) POLYPROPYLENE FIBER

METHODOLOGY

It Consists Of 3 Phases

1ST PHASE: Collection of soil samples in the study area and the pond ash from the thermal power plant, Raichur.

2ND PHASE: Conduction of tests on various mixes

3RD PHASE: Analysis and interpretation of tests results

CONDUCTION OF TESTS

Various tests to be conducted on soil waste mix are

- Specific gravity
- Dry sieve analysis
- Atterberg limits by
- Liquid limit for different soil-waste mixes
- Plastic limit for different soil-waste mixes
- Light compaction test
- Unconfined compression test
- CBR (soaked)

STANDARD PROCTOR TEST

The aim of the test is to determine the dry density and moisture content of soil. Higher compaction needed for

heavier transport. The standard proctor test was developed to give higher standard of compaction.

(FIG.3.3.4a) STANDARD PROCTOR TEST APPARATUS

CBR

California bearing ratio test is primarily to evaluate bearing capacity of soil.this test is mainly performed in laboratory for soaked condition to know the CBR values.

(FIG.3.3.5a) APPARATUS OF CBR TEST

This test is performed o obtain shear strength of soil. The cylindrical specimen is placed and it is subjected to loading till it specimen fails due to shear along a critical plane of failure. Samples were shaped in a mould with a length of 76 mm and an inner diameter of 38 mm at the state MDD and OMC

FIG UNCONFINED COMPRESSION TEST APPARATUS

Table 1. 3 **PREPARATION OF SOIL MIX SAMPLES**

Mixes	Soil (%)	Pond ash (%)	Fiber (%)
S100	100	-	-
S90PA10	90	10	-
S80PA20	80	20	-
S70PA30	70	30	-
S99.85F0.15	99.85	-	0.15
S99.70F0.3	99.70	-	0.3
S89.85PA10F0.15	89.85	10	0.15
S79.85PA20F0.15	79.85	20	0.15
S69.85PA30F0.15	69.85	30	0.15
S89.70PA10F0.3	89.70	10	0.3
S79.70PA20F0.3	79.70	20	0.3
S69.70PA30F0.3	69.70	30	0.3
S99.65F0.45	99.65	-	0.45

Sample preparation and designation of soil waste mix

Table 1. 4: Designation of soil waste mix

Sample	Designation

Soil	S
Pond ash	PA
Fiber	F

III. RESULTS AND DISCUSSIONS

SOIL CLASSIFICATION

SOIL	BLACK COTTON SOIL
APPEARANCE	BLACK
SPECIFIC GRAVITY	2.62
GRAIN SIZE DISTRIBUTION Gravel (%) Sand (%) Silt (%) Clay (%)	 0 15 25 60
Atterbergs limit; Liquid limit, LL (%) Plastic limit, PL (%) Plasticity index, PI (%)	 57 28.18 35.82
IS Classification	CH
Maximum dry density (gm./cm3) Optimum moisture content (%)	 1.687 18

Table 1.5: properties of black cotton soil

Since, more than 50% of soil grains were finer than 75µ, the soil was found to be fine grained soil. Further, as the liquid limit was more than50% and soil was above 'A' line the soil was classified as **FATCLAY soil (CH)** as per IS classification of soil.

TABLE 1.6: LIQUID LIMIT TEST RESULTS

MIX	LIQUID LIMIT
S100	57
S90PA10	53
S80PA20	51
S70PA30	48
S99.85	55
S89.85PA10F0.15	53
S79.85PA20F0.15	50
S69.85PA30F0.15	48
S99.70	54
S89.70PA10F0.3	51
S79.70PA20F0.3	49
S69.70PA30F0.3	47

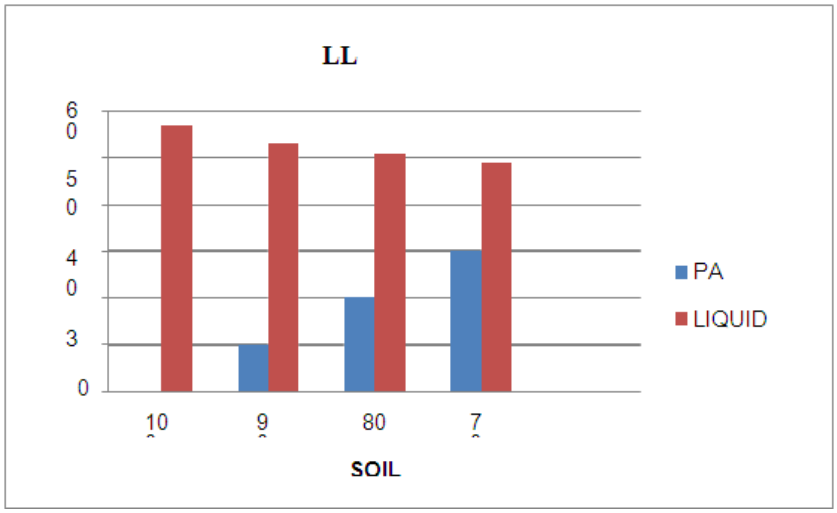
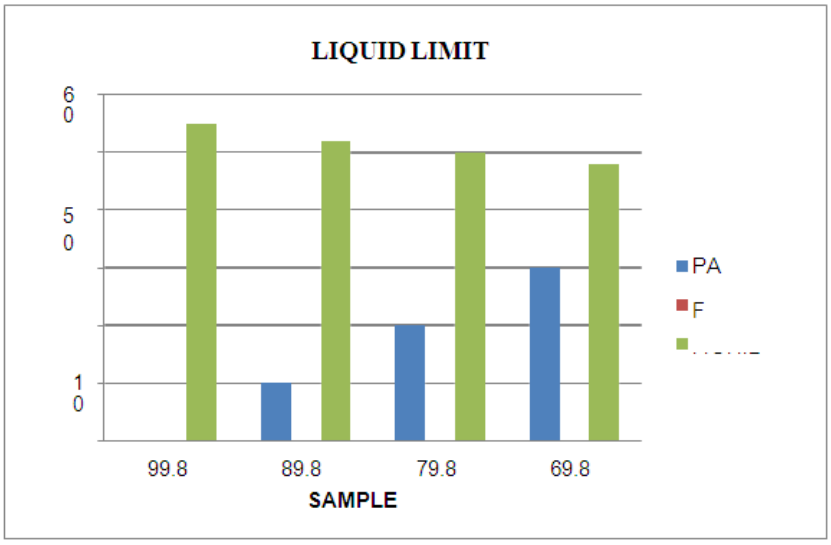
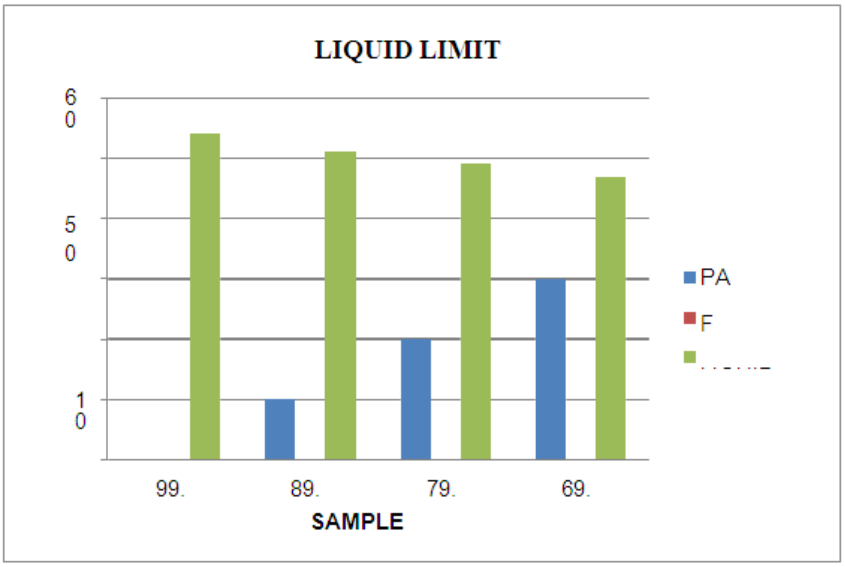


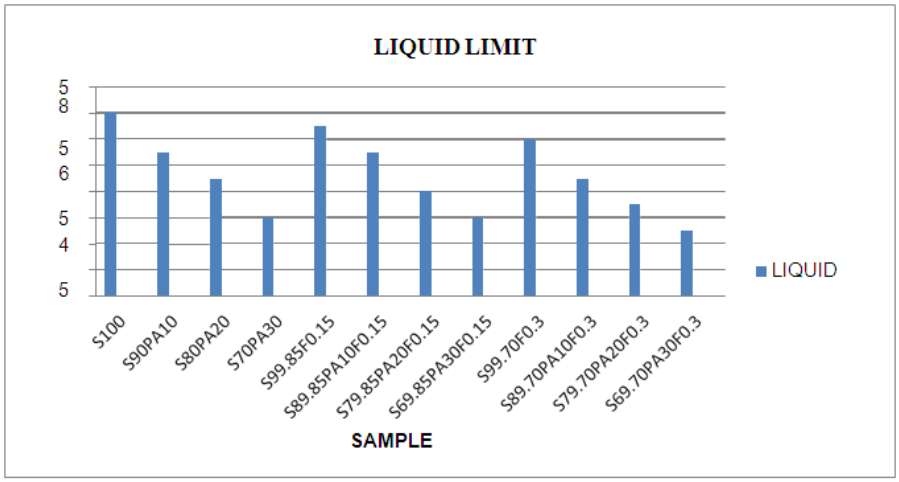
FIG: SOIL & POND ASH



SOIL,POND ASH &FIBER MIX (0.15%)



SOIL,POND ASH &FIBER MIX (0.3%)

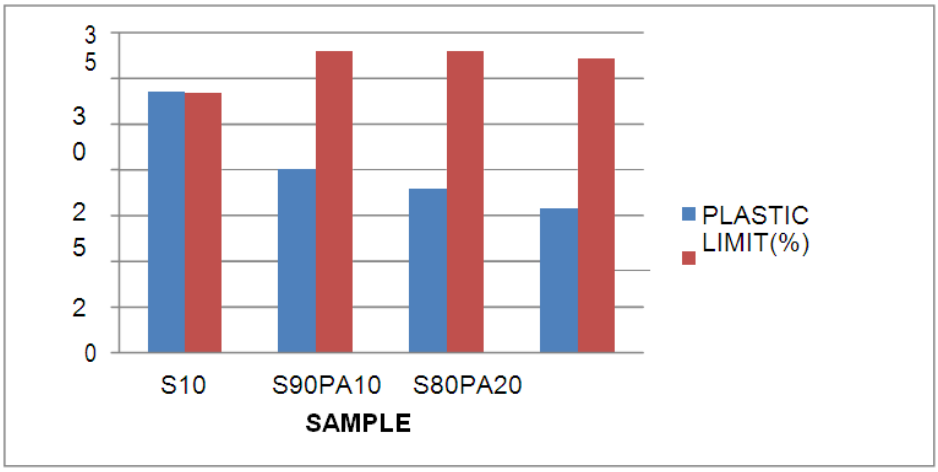


Variation of liquid limit content with varying percentage pond ash and polypropylene fiber (Graph 4.1d)

PLASTIC LIMIT

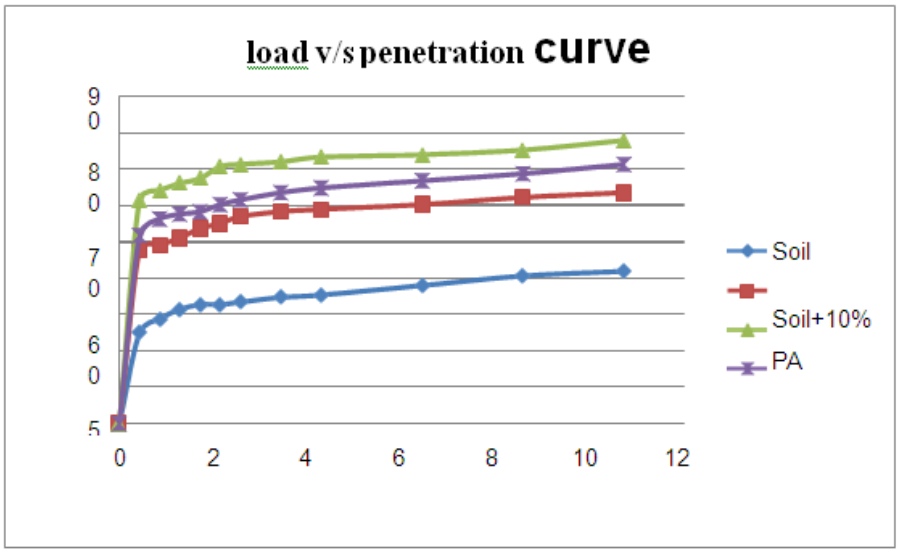
MIX	PLASTIC LIMIT	PLASTIC INDEX
S100	28.57	28.43
S90PA10	20	33
S80PA20	18	33
S70PA30	15.78	32

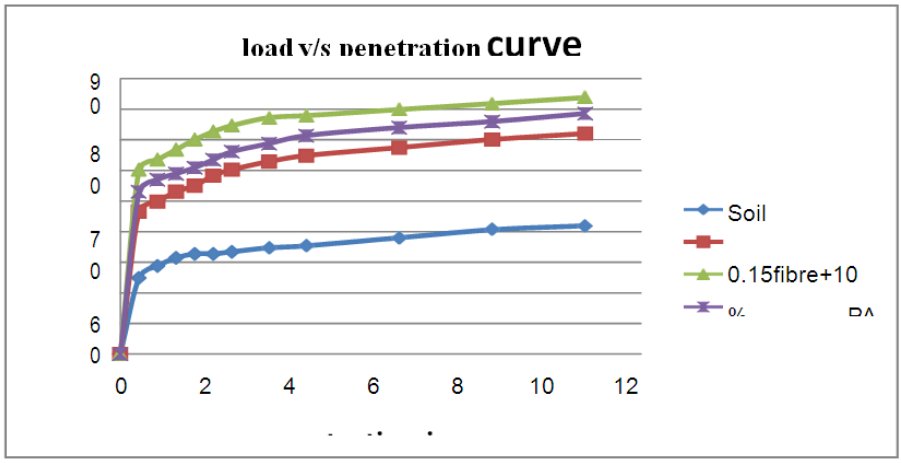
Variation of plastic limit and plasticity indexwith varying percentage pond ash (Graph 4.2a)



CBR TEST

CBR test was conducted on both untreated and treated BC of soil. BC soil was treated with varying percentages of pond ash and Polypropylene fibers. The PA added was 10%,20%and 30%.Correspondingly fiber added was 0.15%. And 0.3% CBR test was conducted as pr IS 2720 (part 16)





Unconfined test

The unconfined compressive strength of soil samples at are presented in table . The stress strain curves for black cotton soil treated with various percentages of pond ash and fiber is shown in figure. It can also be seen that, fiber reinforced black cotton soil exhibits more ductile behavior and smaller loss of post peak strength than black cotton soil alone.

Table1.7.1Unconfined compressive strength test readings of soil samples for various mix proportions

Mix proportions	unconfined compressive strength value(kN/M^2)
S100	113.523
S90PA10	109.29
S80PA20	101.14
S70PA30	93.24
S99.85F0.15	135.2
S89.85PA10F0.15	129.23
S79.85PA20F0.15	123.78
S69.85PA30F0.15	119.9
S99.70F0.3	155.1
S89.70PA10F0.3	143.15
S79.70PA20F0.3	138.9
S69.70PA30F0.3	132.27

From the above results it is found that with increase in pond ash content in fine grained soil pond ash mixture, the value of ucs decreases, it may be due to that with increase in pond ash contents, the fine-grained soil altered into more friable "less clayey" form as a result; there cohesive strength may decline

IV. CONCLUSIONS

- The present project can serve an effective method to utilize pond ash in the stabilization of expansive soil.
- The liquid limit decreased drastically with the addition of pond ash.
- Addition of pond ash brings in decrease in density and increase in OMC by percent adding of pond ash.
- The CBR of the study soil increase gradually with the addition of pond ash up to certain percentage of pond ash, beyond which, further increase in pond ash is observed to cause a decreasing trend in the CBR.
- The polypropylene fibre showed good improvement in the compaction parameters of the study soil by increasing the MDD of soil by decreasing corresponding value of OMC.
- The value of unconfined compression strength (UCS)decreases where as the soaked California bearing ratio (CBR) value of pond ash fine-grained soil mixture increases with addition of pond ash content
- Thus pond ash of 20% and fiber of 0.3% is suitable for stabilization