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Reinforcement of Pond Ash Bed with Recron 3S and Analysis of Its Geotechnical Properties

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ABSTRACT

A huge amount of ash pond is being generated by the thermal power plants and other such processes involving the combustion of coal in developed and developing countries. It has a hazardous effect on the environment and human beings. Some of the largest coal reserves are there in India hence, it is one of the largest producers of coal and coal-based thermal power plant installations. The current rate of deposition of Pond ash in India has reached 160 million tons per annum. Around 90 sq km acres of precious land is used for the storage of abandoned Pond ash. But the current utilization rate of ash is only around one/third of its total production. The fly ash is disposed of in the ash ponds. This practice leads to an ever-increasing ponding area for storing ash and causes environmental issues for the people living around the industrial area including thermal power plants. The developmental projects like the construction of highways and roads have taken a boost in recent years. This requires a huge amount of natural soil and aggregates to be either excavated or deposited. The opportunity cost for such development is an environmental and economic issue. These issues need to be addressed by adopting some alternative methods. Pond ash is one such by-product that can be used as material for filling in some of the geotechnical constructions. It is a non-plastic and lightweight material. The present work describes the effect of moisture content, degree of compaction, synthetic fiber as reinforcement on various geotechnical properties of pond ash are studied.

A series of tests including direct shear test, CBR test, light compaction as well as heavy compaction test, unconfined compression test was performed to estimate the strength characteristics of compacted pond ash using polyester as reinforced material. Physical properties of the pond ash were studied by performing tests like specific gravity test, grain size distribution test by mechanical sieve analysis.

This study is helpful for the successful application of pond ash in different fields such as embankment construction, road base, and sub-base construction, designing of retaining walls, etc. It also provides an eco-friendly approach for the disposal of pond ash.

KEYWORDS: *Fly ash, pond ash, direct shear test, footing load test, light and heavy compaction test, etc*

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1. INRODUCTION

The biggest hazard to environment is waste materials as by-products, which is release by Thermal power plants. During dumping of them, is a chief worry now-a-day. It requires a huge area and also has numerous environmental problems. Main by-products are Fly ash, Bottom ash & Pond ash. Fly ash is calm from the flue gases of the power plants by machine-driven or electrostatic precipitator. Bottom ash is calm from the bed of the boilers. Pond ash is resultant from the assortment of both fly ash & bottom ash. The power plants induce very huge amount of pond ash with respect to fly ash & bottom ash. Consequently, the aim is to operate the ash pond in some supplementary fields to diminish its potential threat to the environment.

With respect to the natural soil, ash pond is very light in weight and it has self-draining ability. It is very essential to recognize the strength parameter of ash previously its effective application in numerous fields. Although during the construction huge structure such as sky scraper, dams (earthen), railway track embankments, bridge abutments and other retaining structures a massive amount of soil is required. Because of rapid industrial development and the insufficiency of accessibility of natural soil the scientists believed to operate the by-products of power plants as auxiliary to the soil. Though this the environmental issues because of deposition of the waste products would be solved and this may also diminish the scarceness of natural soil.

At present-days situation the utilization of ash pond in India in other fields is insignificant or negligible. Only about 30 to 35 presents of the ash pond are actually utilized commercially. It represents that in order to perpetuate the precious natural soil, it is obligatory to utilize the ash pond to the maximum level. Latterly ash Pond is being utilized as a filler material in low lying zones. It would also be utilized for embankment construction in some respect. Though, its utilization is inadequate due to stringency of adequate knowledge about its necessary parameter and some other physical characteristic.

With respect to the conventional earth material the strength (bearing strength) of ash pond is lesser because of fewer angle of internal friction & interlocking b/w the particles as the shape of ash pond particles are surrounded. By reinforcing of ash pond with adequate material that will enhance its geotechnical characteristic alike in instance of reinforced earth. For that, the information about the strength characteristics of natural soil mass and the reinforcement is very abundant vital.

1.1. Objective of Study

The main emphasis of the present study is to enhance the geotechnical properties of ash pond. Several endeavors had been made previously by the investigators to understand the procedure of fiber insertions unified into ash pond to enhance its geotechnical characteristic beside that strength by co-operating with the ash pond particles mechanically by interlocking of particles and surface friction.

The present analysis is an attempt that has made to enhance the geotechnical engineering properties of modified ash pond by using Recron-3S by means of the reinforcing material

2. MATERIAL USED

The resources used for the trial work are, Ash of pond, Recron 3s

2.1. Ash pond the ash pond was collected in gunny bags from GGSS Punjab. It was dried in the oven at 100˚C-115˚C and kept in an airtight container for further use.

2.2. Recron-3S Use of Recron 3S is an art of state in reinforcing material which is used to increase strength in variety of applications like pre-cast products, filtration fabrics etc. it belongs to polyester family of fibers. It also imparts resistance to impact, and greatly improves the superiority of construction during foundation, design of retaining wall etc.

2.3. Uses of Recron-3S

2.3.1. Cracking reduction
2.3.2. Diminish permeability
2.3.3. Induce flexibility
2.3.4. Easily available to use

2.4. Physical properties

Physical properties of ash pond are signified in Table 2.1

S. no	Properties	Value
01	Color	Light grey
02	Shape	Rounded
03	Uniformity coefficient	1.82
04	Coefficient of curvature	1.4
05	Plasticity Index	Non-Plastic

Racron 3S

Racron 3S is most adapted polyester. Normally it is used as reinforcing material in soil and concrete to enhance their recital. Its sample used in experiment was of size 1.2 cm and manufactured by Reliance industry limited.

Physical properties of Racron-3S

The physical properties of Racron-3S are represented in Table 2.3.

S. no	Properties	Value
01	Diameter	40-45 micron
02	Elongation	>100 %
03	Cut length	0.25 cm,0.5 cm,1 cm
04	Melting point	230-250 C
05	Softening point	230 C
06	Specific gravity	1.23-1.35
07	Cross section	Depends (Cylindrical)

2.5. Chemical compositions

Composition of ash pond is tabulated below in Table 2.2.

S. no	Properties	Value in%
01	SiO_2	58-60
02	Al_2O_3	27.5-28
03	Fe_2O_3	2.75-5.20
04	Na_2O	0.23-0.50
05	K_2O	1.27-1.75
06	CaO	0.7-01
07	MgO	1.40-1.85
08	LOI	0.5-3

3. EXPERIMENTAL WORK

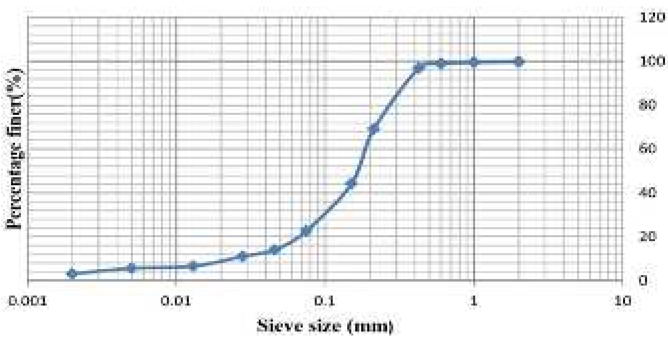
3.1. Specific gravity of ash pond

Density bottle method was used to determined Specific gravity of ash pond and consequence as 2.36 experimentally done

3.2. Determination of grain size distribution of ash pond

Ash pond comprises of both fine & coarse particles. Sieve analysis was done for coarse particle. Hydrometer method was applied to finer particle. Particle size distribution curve was plotted b/w percentage finer and particle size. Co-efficient of uniformity & co-efficient of curvature were found out using the following formula.

Coefficient of uniformity, $\{C_u = D_{60} / D_{10}\}$
Coefficient of curvature, $\{C_v = (D_{30})^2 / (D_{60} \times D_{10})\}$



Fig(3.1) The grain size distribution curve

3.3. Compaction test of ash pond

In order to determine moisture content, dry density relationship of soil compaction tests is commonly used. In light compaction test ash pond at variable water content was compacted in the mould in 3 layers with 25 blows in each layer given by a rammer of 2.6 kg with a drop of 31cm, in case of heavy compaction test ash pond at variable water content was compacted in the mould in 5 layers with 25 blows in each layer given by a rammer of 4.5 kg with a fall of 45cm. a graph was plotted b/w moisture content & dry density. From which OMC and MDD values were found out. Compaction tests were carried out for different compaction energy by varying the No. of blows given by hammer and presented

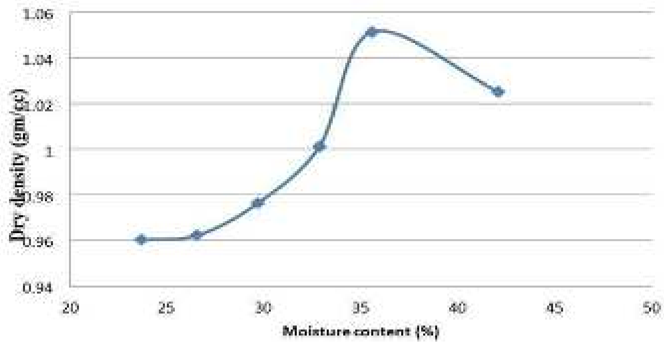


Fig (3.2) Dry density variation of ash pond with moisture content at compaction energy 590kJ/m³

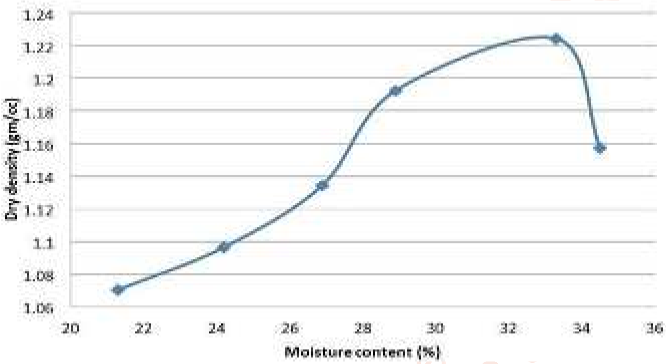


Fig (3.3) Dry density variation of ash pond with moisture content at compaction energy 2573kJ/m³

Direct shear test of ash pond

The direct shear test is performed to determine the c and Φ values of ash pond. Box with a dimension 60*60*50 mm depth is used. Specimen of dimension 60*60*24 was prepared at MDD and OMC and sheared with a constant strain for different normal stress. A graph is plotted between shear stress verses normal stress. Through which c and Φ values are found out. Direct shear test was performed for the soil samples at light compaction density and heavy compaction density with variable fiber content and consequences are shown

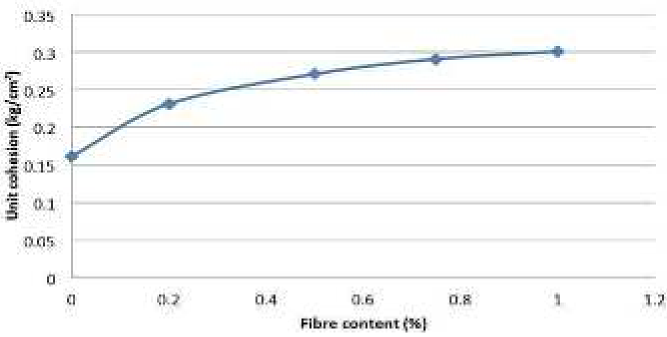


Figure (3.4) Variation of unit cohesion with fiber content (light compaction MDD

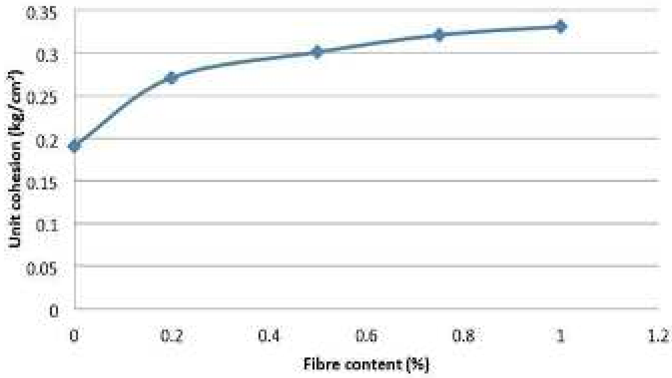


Figure (3.5) Variation of unit cohesion with fiber content (heavy compaction MDD

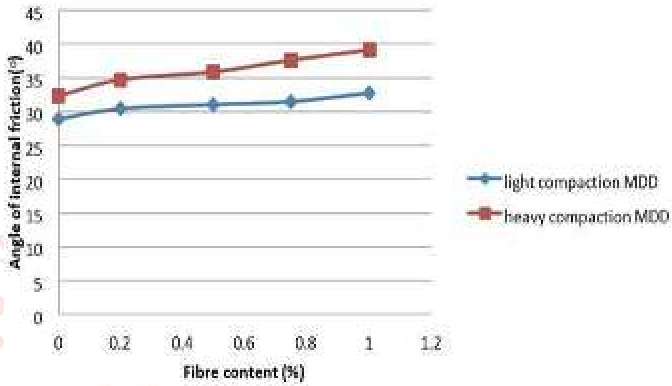


Figure (3.6) Variation of angle of internal friction with fiber content

Unconfined compression test of ash pond

Pond ash sample along with fiber & without it was equipped at maximum dry density & optimum moisture content corresponding to light as well as heavy compaction test. Unconfined compression was done to examine UCS value of respective samples. Consequences are shown in table 3.8 and 3.9. For unreinforced ash pond as well as reinforced ash pond Stress strain relationship are given in figure 7 to 10 Though varying in fiber content from 0 to 1 % UCS value varied from 0.24 to 0.44 at light compaction MDD and OMC.

Correspondingly, UCS value change from 0.23 to 0.42 with varying in fiber content 0 to 1% at heavy compaction MDD and OMC. On increase in percentage of fiber in ash pond corresponding UCS value is also increase. Increasing rate is not constant. Primarily the rate of increment is more in UCS; progressively its value decreases beside increase in % of fiber

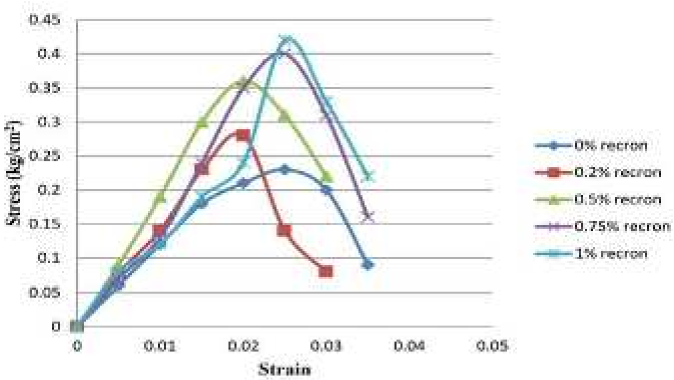


Figure (3.7) Stress vs. strain relationship (light compaction MDD)

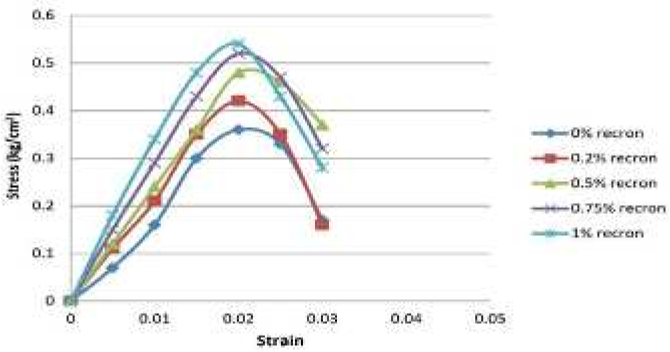


Figure (3.8) Stress vs. strain relationship (heavy compaction MDD)

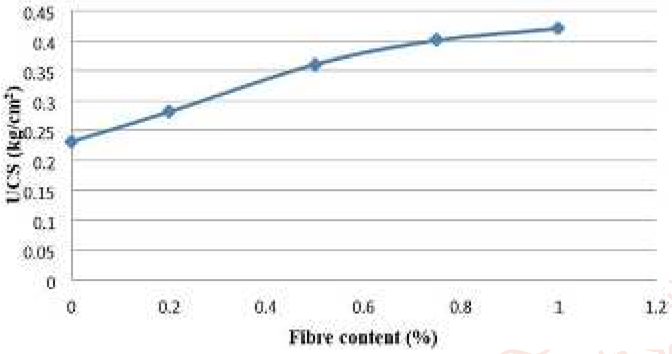


Figure (3.9) Variation of UCS with fiber content (light compaction MDD)

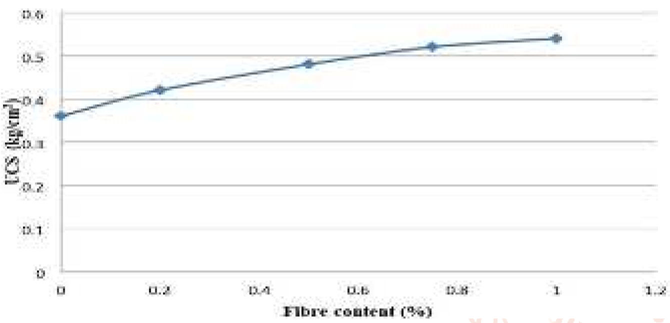


Figure (3.10) Variation of UCS with fiber content (heavy compaction MDD)

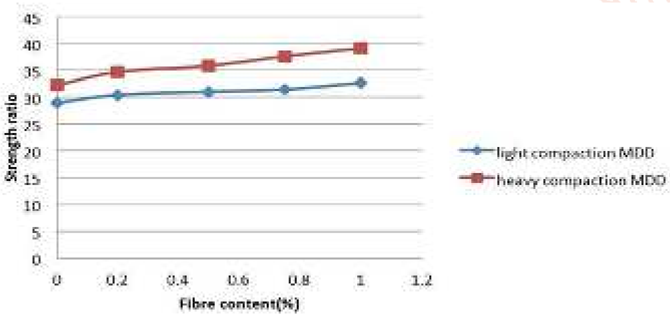


Figure (3.11) Variation of strength ratio with fiber content

4. CONCLUSION

On the basis of obtained experimental results, following conclusion is derived.

- Being a non-plastic nature of pond ash liquid limit and plastic limit (Atterberg's limit) can't be determined. As per PSD curve pond ash is a well graded soil with specific gravity of 2.36 as experimentally determined that may help in building light embankment over lose soil.
- Maximum dry density and Optimum moisture content varied from 1.034gm/cc to 1.235gm/cc and from 37.8% to 34.6% on varying in compactive energy from 590kJ/m^3 to 2573kJ/m^{3}respectively. MDD increase with increase in compaction energy. How-ever, its non-linearly dependent to compaction efforts. Whereas OMC decrease with compaction energy.
- Unconfined Compressive Strength test value increased from 0.24 kg/cm^2 to 0.44 and from 0.36 kg/cm^2 to 0.54 kg/cm^2 kg/cm^2 on varying the percentage of fiber content from 0 to 1 % at light and heavy compaction (MDD and OMC). respectively Ductility characteristic also increase, whereas change in UCS value in not linear
- On increment in degree of saturation up-to 82.64 percent, Ultimate bearing capacity of pond ash would increase and then start decreasing afterward.

A reinforced pond ash exhibits enough good engineering characteristic as of natural earth material. Subsequently, natural earth material could be replaced by reinforced pond ash in certain geotechnical structures such as earthen dam, embankments, etc.

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