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Soil Stabilization from Dredged Soil of Dal Lake, Srinagar using Pond Ash for Pavement Design

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***Abstract*:- Dal Lake is a lake in Srinagar, Jammu and Kashmir. A noteworthy ecological issue confronting the lake today is the concerning rate of residue deposition in the lake. The extent of dredged silt being produced from the Dal Lake poses a genuine disposal and natural environmental issue all-around the Lake. Therefore, a critical need to consider reuse of this dredged soil arises. In the following paper, the unwanted material from the Dal Lake has been treated with the industrial waste pond ash, which from the various researches has proven to be potent in the improvement of weak and poor soils for the beneficiary use of the soil in pavement design. This paper aims to investigate ways in which the unwanted dredged soil could be used as a benefit to pavement construction, by carrying out the CBR test. The percentages of pond ash as the admixture in improving the California Bearing Ratio (CBR) used are 2.5%, 5%, 7.5%, 10% and 12.5%. The optimum moisture content increases and the dry density decreases with the increase in the percentages of the pond ash, the addition of pond ash enhances the CBR (un-soaked and soaked) values. The increase of 80% in the unsoaked CBR value and of 90% in soaked CBR value were observed with the addition of the pond ash. Thus the dredged soil mixed with the pond ash can be used for the construction of embankments and stabilization of the sub grade soil.**

Keywords- Soil stabilization; ecological issues; Dal Lake; pond ash; dredged silt

I. INTRODUCTION

Dal is an urban lake situated in northeast of Srinagar at an elevation of around 1586m above ocean level having geographical coordinates of 34°07′N 74°52′E. The lake is shallow with saucer formed basin and has an open drainage i.e. regular inflow and outflow of water happens. There are two speculations for the birthplace of the lake – one expresses that it is a post-glacial lake, the other hypothesis of the source of the lake expresses that the Dal Lake was formed because of flood spillage from the Jhelum River. Dal Lake has an average depth of around 5 feet and a maximum depth of 20 feet. Covering a region of 18 km^2, the Dal Lake is a piece of a characteristic wetland that covers a territory of around 21 km^2 which incorporates floating gardens. The Dal Lake is isolated into four basins, Bod Dal, Nagin (also a different lake), Gagribal and Lokut Dal. There is an island amidst Bod Dal known as Sona lank. Lokut Dal is otherwise called Rup Lank and Char Chinari The sample of the dredged soil which has been accumulated in the lake due to the floods was collected from the basin of the dal lake near the road to garden on foreshore road.

Dredging from the lake produces dredged material in great quantity. The issues encompassing the transfer of this extensive amount of material will significantly affect both the finances and the environment of the region. Mir (2016)[4] concluded that in-situ dredged soil is composed of silt, sand, clay and organic matter, which is not suitable as a construction material in its in-situ condition. However, treated dredged soil can be utilised as a resource for various engineering applications and a stabilizer for improving behaviour of fine grained soils. The present arrangements are to discard the uncontaminated dredged soil from the lake either on shoreline or in filling low lying areas surrounding the lake, both of which face resistance from ecological gatherings and nearby fishermen. The movement of substantial volumes of dredged material from one area to the next disturbs existing living spaces at both the dredged site and the transfer site. Due to the vast measure of dredged silt being created from the lake, there is a desperate need to consider reuse than to transfer. One such use could incorporate fill for highways.

Out of the total Solid Waste generated in India, roughly 25% is buildup from coal ignition. These residues incorporate fly ash, bottom ash and pond ash. Pond ash is a mixture of dry fly ash and bottom ash. During the years 2010-12, around 408 million tons/year of coal was utilized and more than 130 Million tons/year of fly ash was generated by 88 thermal power plants all over India. Pond ash adds to two major environmental issues: generation of respirable particulate matter (a major air pollutant) and contamination of soil and water because of leaching of heavy metals. Suresh, I. V., et al. (1998)[5] concluded that

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ground water quality is deteriorated due to the presence of fly ash ions (macro and micro such as Fe, Ca, Mg etc.) which were leached out from the ash up to some extent. The contamination is likely to increase in the case of toxic and other ions with the passage of time.

In the present study pond ash obtained from National Thermal Power Corporation (NTPC) Ramagundam, Telangana, India, was used to stabilize the dredged material. The idea of using pond ash as a stabilizing agent was born from extensive literature review. Kolay, et al. (2011)[3] concluded that maximum dry density (MDD) and unconfined compressive strength (UCS) increases and optimum moisture content (OMC) decreases with increase in the percentage of pond ash. Table I lists the various properties of pond ash used in the study.

TABLE I. Properties of Pond ash used in study

Parameter	Values
Specific Gravity	1.97
Particle Size Distribution: Gravel particle size Sand particle size Silt particle size	 7.19% 80.52% Nil
Consistency	Non-Plastic
Coefficient of Uniformity, Cu	4.65
Coefficient of Curvature, Cc	0.84
IS Heavy Compaction test results: Maximum Dry Density Optimum Moisture Content	 1.17 g/cc 28.90%
Classification as per IS: 1498-1970	SP

A. Objective

The objective of this paper is to make use of dredged material from Dal Lake in pavement designing with the help of pond ash, used as the additive in the different percentages with the soil to enhance the CBR values for both unsoaked and soaked conditions, to make it useful in the construction of embankments and stabilization of the sub grade soil.

B. Methodology

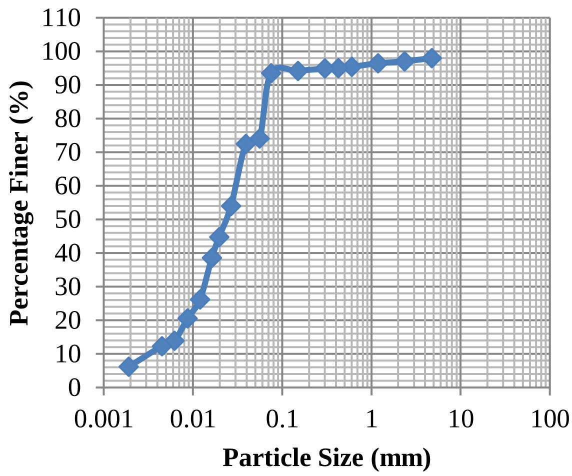
- Collection of the dredged soil from the Dal Lake.
- Collection of the Pond Ash and characterization of Pond Ash.
- Conducting series of laboratory tests which include Natural Moisture Content, Specific Gravity, Grain Size Analysis, Standard Proctor Compaction, Unconfined Compressive Strength, Direct Shear Test, and California bearing ratio (CBR) on the dredged soil.
- Conducting compaction & CBR tests on the dredged soil when mixed with the different proportions (2.5%, 5%, 7.5%, 10% and 12.5% respectively by the weight of the soil sample) of the Pond Ash.
- Analysis of results to find the optimum amount of the pond ash which is to be mixed with the dredged soil for its beneficiary use in pavement design.

II. EXPERIMENTAL PROGRAMMME

The dredged soil obtained from the lake was subjected to a series of laboratory test to determine its physical and engineering properties which are listed in table II.

Table II. Physical and engineering properties of dredged soil

Properties	Results
Water Content	33.2%
Specific Gravity	2.54
Soil Classification Silt particle size Sand particle size Gravel particle size	ML 87% 4% 1%
Coefficient of curvature C_c Coefficient of Uniformity C_u	2.34 9.38
Atterberg's Limits Liquid limit Plastic limit Shrinkage limit Free swell index Plasticity index A line U line	 34.60% 29.22% 14.34% 30% 5.38% 10.66 23.94
Compaction Test Results OMC MDD	 19% 1.725 g/cc
Unconfined Compressive Strength	160 kPa
Direct Shear Test c φ	 40.95 kN/m^2 48.46^o



The graphs for soil classification, UCS, Direct shear Test (DST) for dredged soil are shown respectively in Fig. 1, 2 & 3.

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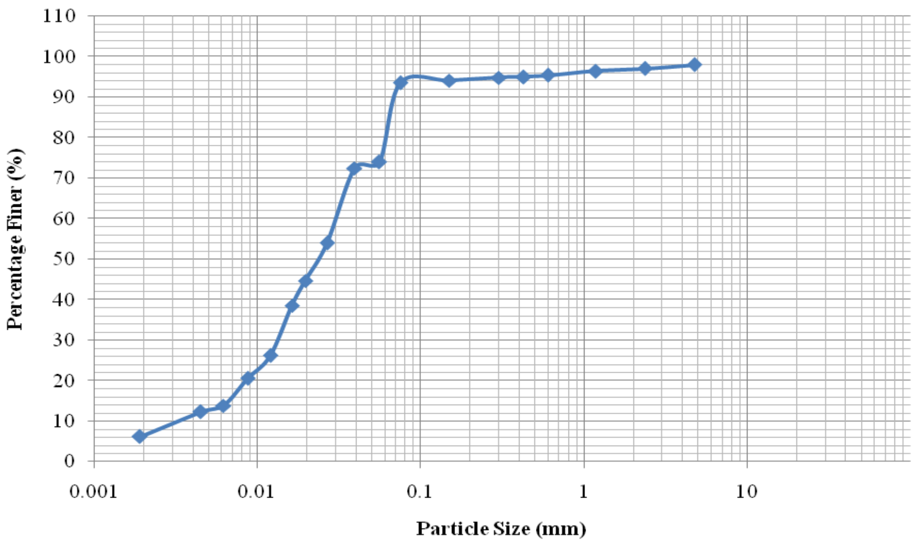

Fig. 1. Grain size distribution curve.

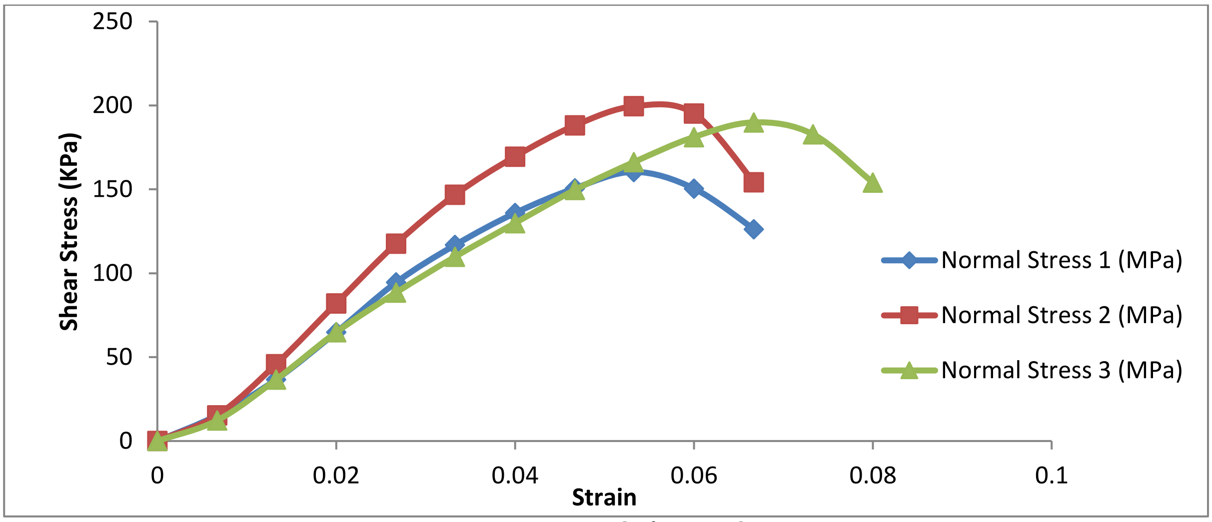

Fig. 2. UCS test results for 3 samples.

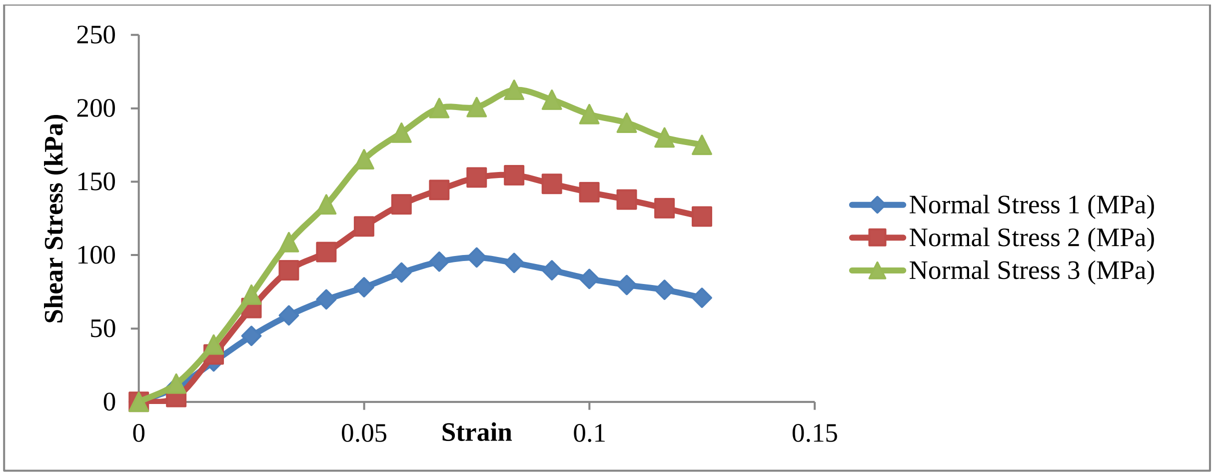

Fig. 3. DST test results.

III. EFFECT OF POND ASH ON DREDGED SOIL

A. Compaction Characterization of Soil with Pond Ash

The maximum dry density (MDD) and optimum moisture content (OMC) are the benchmark for determination of quality compaction for any earth work project. A summary of the results of standard Proctor compaction tests on Dal Lake dredged soil stabilized with various percentages of Pond Ash are shown in graph below. Figure 4(a) and 4(b) show the optimum moisture content versus pond ash content curve and maximum dry density versus pond ash content curve respectively. A decrease in MDD and increase in OMC with addition of pond ash content is observed.

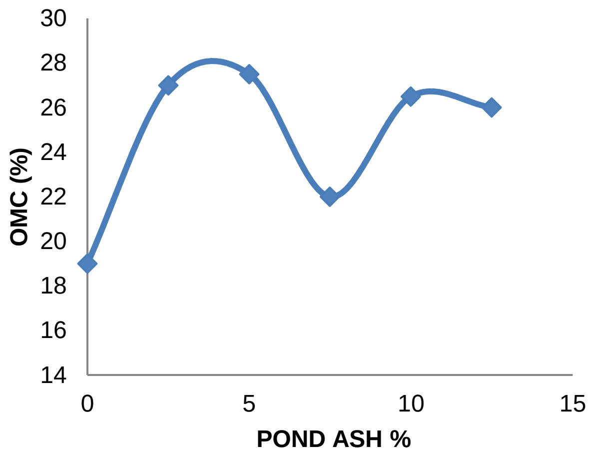

Fig. 4(a). Effects of pond ash on OMC

- *Effects of Pond Ash on OMC*
  The optimum moisture content (OMC) of the soil increases with increase in pond ash contents due more absorption of water by pond ash. Addition of pond ash in soil increases the amount of finer material in the mix. Hence due to more specific surface area, mix requires more amount of water for proper packing and coating all particles, which causes the increase in the OMC.

- *Effects of Pond Ash on MDD*
  Maximum dry density decreases with increase in Pond Ash due reduction in cohesion between soil and pond ash particles and due to the low specific gravity of pond ash as compared to soil.

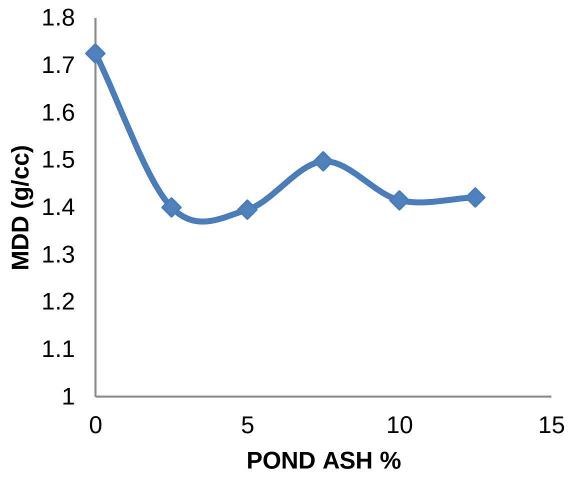

Fig. 4(b). Effects of pond ash on MDD

B. CBR Test Results with Pond Ash

CBR is a means for classifying the suitability of a soil for its use as a subgrade, sub-base or base material in highway construction. It was developed by the California Division of Highway Department in 1929. The CBR values are commonly used as an indicator of strength and bearing capacity of a subgrade soil, sub-base and base course material in road and airfield pavements. [1] In the present study, two samples were prepared for CBR tests; one was tested directly after sample preparation and the other after soaking the prepared sample in water for 96 hours. The test was carried out under a seating pressure of 4.5 kg.

- *Sample Preparation*
  The CBR samples were prepared by a standard mold with an internal diameter of 152.4 mm (6 inches) and a height of 177.8 mm (7 inches). The soil was mixed with the Pond Ash in percentages of 2.5%, 5%, 7.5%, 10% and 12.5% respectively by the weight of the soil sample taken. The mixed soil samples were compacted to a maximum dry density at the optimum moisture content determined by standard proctor tests for the respective percentages of the pond ash. The soil samples were compacted in 3 layers with 56 blows each and tested with and without soaking in water [2]. The standard CBR values for the different percentages of the Pond Ash are shown in the Fig. 5 below for both unsoaked and soaked samples. The CBR value is calculated according to the following formula:

$$\textbf{CBR} = \frac{\textit{Measured Pressure}}{\textit{Standard Pressure}} \times 100 \qquad (1)$$

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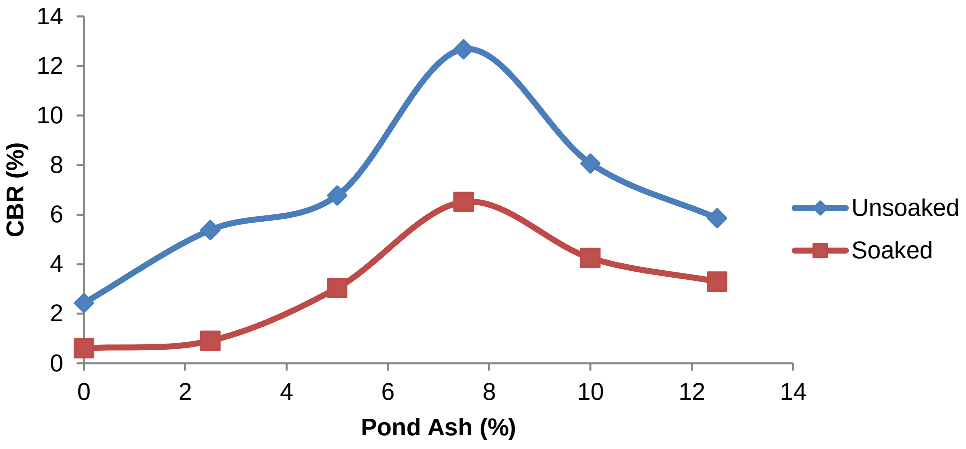

Fig. 5. Variation of unsoaked and soaked CBR values with Pond Ash

It was observed from Fig. 5, that the unsoaked CBR value of the soil first increases with increase in the Pond Ash content and then at the 7.5% of Pond Ash it attains the peak value. On further increasing the pond ash content, CBR value is reduced. The addition of the Pond Ash in the dredged soil enhances the unsoaked CBR value by 5 times the corresponding value of the virgin soil.

The soaked CBR values also increased with the increase in the Pond Ash content and attains the maximum value at 7.5% and then with further increase in the Pond Ash content, the decrease in the values of the CBR was observed. The addition of the Pond Ash in the dredged soil enhances the soaked CBR value by 10 times the corresponding value of the virgin soil.

IV.CONCLUSION

For the sake of protecting the Dal lake from the deposition of the dredged soil in it and to make the better utilization of the dredged soil and pond ash in the field of the geotechnical engineering and construction for pavement, it was important to understand the impact of pond ash on the behavior of the dredged soil. In the present study the effects of the Pond Ash on the CBR value of the soil was briefly discussed through which it can be concluded that the optimum value of the Pond Ash to be used to enhance the CBR value (both unsoaked and soaked) for the use of the soil in the pavement construction is 7.5%.

Also, consumption of the dredged soil and Pond Ash in the bulk quantity for construction of road projects can reduce the environmental impact of the waste generated from the lakes and industries.

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