Soil Stabilization from Dredged Soil of Dal Lake, Srinagar using Lime 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 lime, 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 lime 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 lime, the addition of lime enhances the CBR (un-soaked and soaked) values. The increase of 87% in the unsoaked CBR value and of 96% in soaked CBR value were observed with the addition of the lime. Thus the dredged soil mixed with the lime can be used for the construction of embankments and stabilization of the sub grade soil.**

Keywords:- Soil stabilization; ecological issues; Dal Lake; lime; 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 utilized as a resource for various engineering applications and a stabilizer for improving behavior 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.

Lime is used as an additive to stabilize the dredged soil to improve its CBR value for its beneficial use in the pavement design. Bell (1996) [2] while subjecting Kaolinite, Montmorillonite and Quartz to a series of tests stated that all materials experienced an increase in their optimum moisture content and a decrease in their maximum dry density, as well as enhanced California bearing ratio, on addition of lime. In the investigation it was bought from the local market of Srinagar near the old secretariat which was high calcium lime CaO2. Singh and Pani (2014) [5], while evaluating the feasibility of lime stabilized fly ash as a highway material concluded that with addition of lime maximum dry density increases and optimum moisture content decreases. Also, addition of lime results in filling the voids of the compacted fly ash thus increases the density.

A. Objective

The objective of this paper is to make use of dredged material from Dal Lake in pavement designing with the help of locally available lime, used as the additive in the different percentages with the soil to enhance the CBR values for both unsoaked and soaked of the dredged soil to make it useful in the field of construction.

B. Methodology

- Collection of the dredged soil from the Dal Lake.
- Collection of the lime from the local market of Srinagar, Jand K.
- 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 and 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 lime.
- Analysis of results to find the optimum amount of the lime 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 I.

Table I. 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 Cohesion (c) Angle of shearing resistance(Φ)	 40.95 kN/m^2 48.46°

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

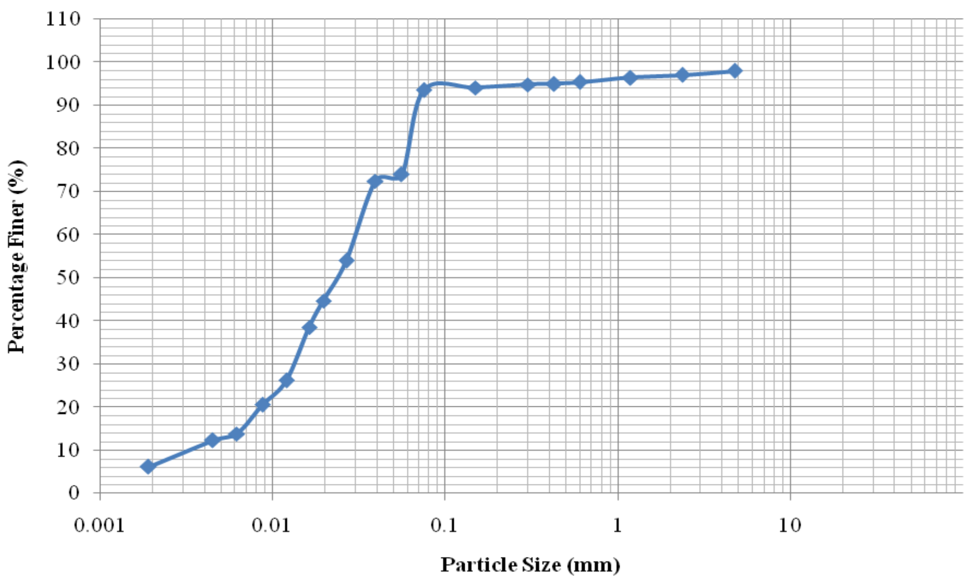

Fig. 1. Grain size distribution curve.

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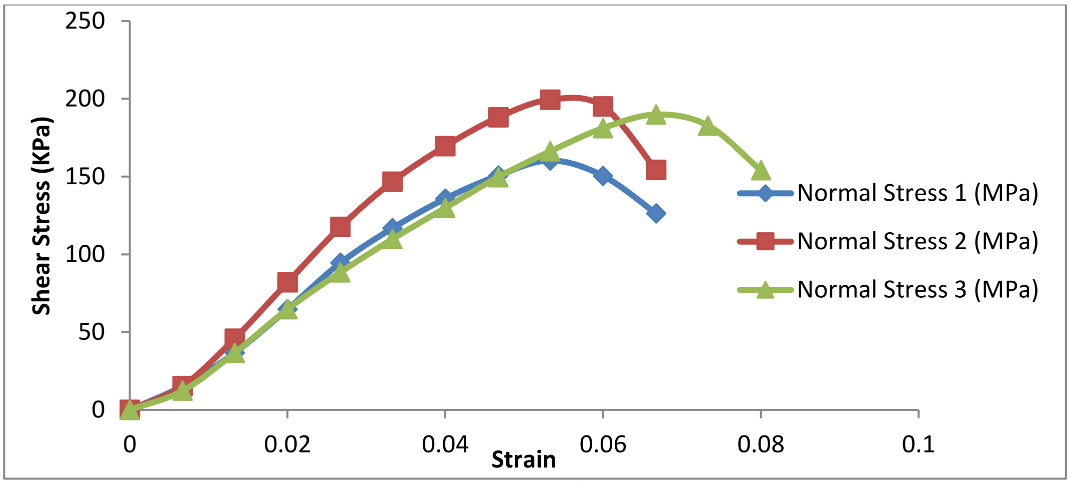

Fig. 2. UCS test results for 3 samples.

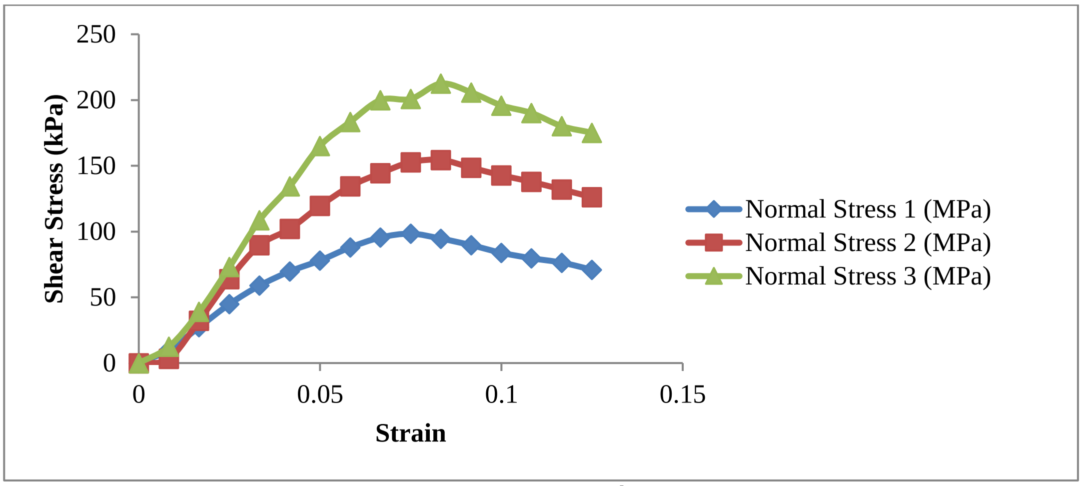

Fig. 3. DST test results.

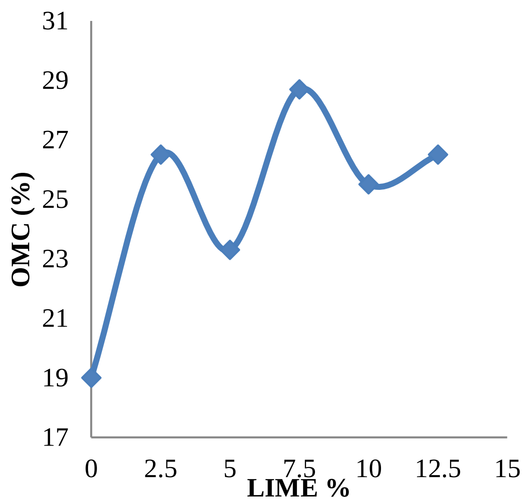

Fig. 4(a).Effects of lime on OMC

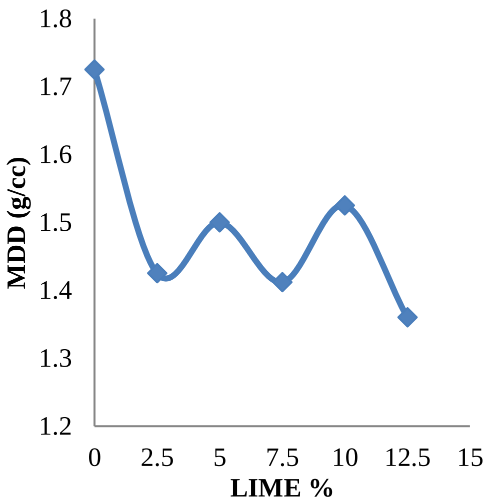

Fig. 4(b). Effects of lime on MDD

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III. EFFECT OF LIME ON DREDGED SOIL

A. Compaction Characterization of Soil with Lime

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 Lime are shown in graph below. Figure 4(a) and 4(b) show the optimum moisture content versus lime content curve and maximum dry density versus lime content curve respectively. A decrease in MDD and increase in OMC with addition of lime content is observed.

- *Effects of Lime on OMC*
  The optimum moisture content (OMC) of the soil increases with increase in lime contents due more absorption of water bylime. Addition of lime 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 Lime on MDD*
  Maximum dry density decreases with increase in lime due reduction in cohesion between soil and lime particles and due to the low specific gravity of lime as compared to soil.

B.CBR Test Results with Lime

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 lime 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 lime. The soil samples were compacted in 3 layers with 56 blows each and tested with and without soaking in water. [3] The standard CBR values for the

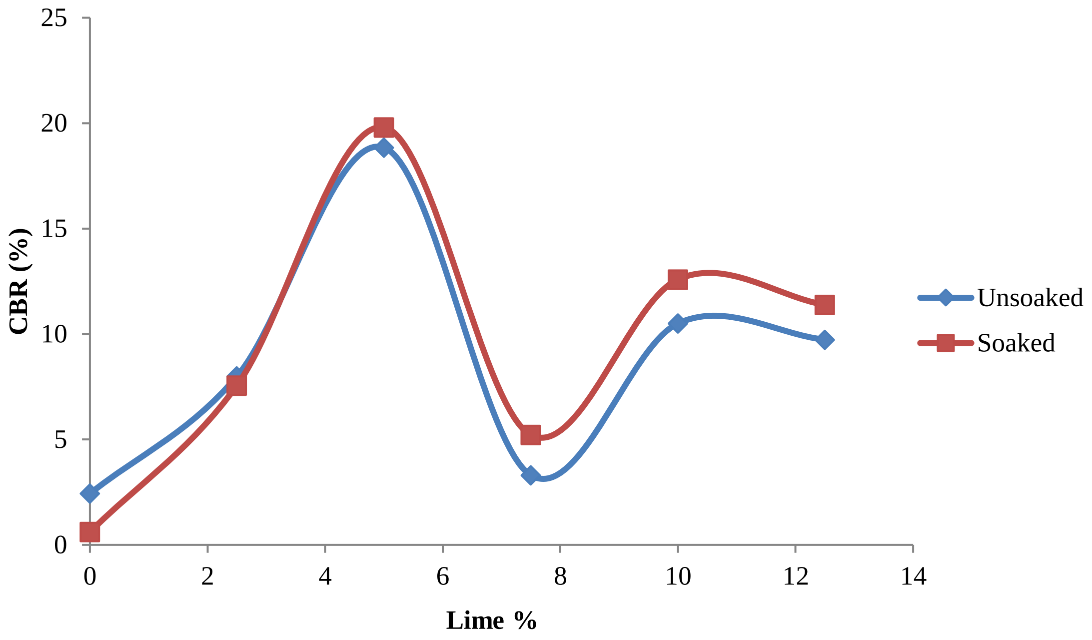

Figure 5: Variation of unsoaked and soaked CBR values with Lime

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different percentages of the lime are shown in the Fig. 5 above for both unsoaked and soaked samples.

$$\boldsymbol{CBR} = \frac{Measured\ Pressure}{Standard\ Pressure} \times 100 \quad (1)$$

It was observed from Fig. 5, that the CBR value for the dredged soil increases with the increase in the lime because of the pozzolanic action between soil and lime and higher lime content produces higher cementing agents, which binds the particles effectively. It gets its maximum CBR value at 5% for the unsoaked CBR, then again decreases with increase in the lime content. The addition of the lime in the dredged soil increased the value of CBR by 16%.

The results for the soaked (4 days) samples shows the increment in the values of CBR with increase in the lime content and attains the maximum value at 5% lime content and then further decreases with increase in the lime content. It is also seen that the values of the soaked CBR at 5%, 7.5%, 10% and 12.5% of lime are more than the values obtained at the same percentages of lime for the unsoaked CBR. The minimum time required for completion of colloidal stage of reactions followed by pozzolanic stage reactions is generally 72 hours. Hence, production of cementing agents commences from 3days onwards. The progressive increase in the soaked CBR values than the unsoaked CBR values has taken place due to the development of the cementing agents. The addition of the Lime in the dredged soil increased the CBR value by 19%.

IV. CONCLUSION

For the sake of protecting the Dal Lake from the deposition of the dredged soil and for better utilization of dredged soil and lime in the field of the geotechnical engineering and construction for pavement, it was important to understand the impact of lime on the behavior of the dredged soil. In the present study the effects of the lime on the CBR value of the soil was briefly discussed through which it can be concluded that the optimum value of the lime to be used to enhance the CBR value (both unsoaked and soaked) for the use of the soil in the pavement construction is 5%. Also, consumption of the dredged soil and lime in the bulk quantity for construction of road projects can reduce the environmental impact of the waste generated from the lakes i.e. dredged soil.

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