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GEO-ENGINEERING CHARACTERISTICS OF LIME TREATED DREDGED SEDIMENTS FROM DAL LAKE SRINAGAR

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ABSTRACT

The ecosystems of wetlands of Kashmir valley are under tremendous anthropomorphic pressure since from last few decades. The loss of wet lands of Kashmir valley aggravated the present situation of flood fury as seen in September 2014 floods in Kashmir. The damage caused to life and property could have been minimized if the water bodies like Wullar, Anchar, Dal, Manasbal and other wetlands had been safeguarded. In the last 30 years, nearly 50 percent of the wetlands in the Kashmir valley have been encroached and damaged severely. The scheme for shoreline dredging of Dal Lake has been formulated but dredging of these Lakes generates dredged material in bulk from various basins. The issues of disposal of this very large quantity of material will have a significant impact on both economic developments in the region and the environment. Current plans are to dispose of the uncontaminated sediments from these lakes either on shoreline of lake or in filling low lying areas surrounding the Lake, both of which face opposition from environmental groups and local fishermen. A noteworthy step is being taken by this study to achieve economic use of dredged material by attempting to improve its properties to meet the requirements for another form of construction.

Keywords*: *Dredged material, Lime, Stabilization

I.INTRODUCTION

Concern over environmental effects of dredging, disposal of dredged material, and the increasing unavailability of suitable disposal sites, has put pressure for characterization of this material as a resource for various beneficial uses/engineering applications. Beneficial use of dredged material is an integral and necessary part of dredge material management process. A number of physical, chemical, and biological tests have been described by the USACE (Winfield and Lee, 1999) [1] to characterize sediments for beneficial reuses including construction and engineering applications. Mir & Shah (2013) [2] reported that dredged material from Dal lake consists of uniformly graded to well graded sand with poor to good fill material characteristics, which can be recommended as fill material for low lying areas, land improvement, agricultural use etc. Soil stabilization aims

at improving soil strength and increasing resistance to softening by water through bonding the soil particles together, water proofing the particles or combination of the two (Sherwood, 1993). The chief properties of soil which are of interest to engineers are volume stability, strength, compressibility, permeability and durability (Ingles and Metcalf, 1972[3]; Sherwood, 1993; EuroSoilStab, 2002[4]). The addition of lime to reactive fine-grained soils has beneficial effects on their engineering properties, including reduction in plasticity and swells potential, improved workability, increased strength and stiffness, and enhanced durability. In addition, lime has been used to improve the strength and stiffness properties. Lime can be used to treat soils to varying degrees, depending upon the objective. Lime modification describes an increase in strength brought by cation exchange capacity and cementing effect brought by pozzolanic reaction (Sherwood, 1993)[5]. In soil modification, as clay particles flocculates, transforms natural plate like clays particles into needle like interlocking metalline structures. Clay soils turn drier and less susceptible to water content changes (Roger et al, 1993) The long term result of pozzolanic reactions is solidification of the soil (Haussmann, 1990).

II.EXPERIMENTAL PROGRAM

The aim of this proposed study is to examine whether lime treatment could be a solution to stabilize dredged material. The soil samples for the present study were taken from the site along the bank of Dal Lake, Srinagar. Sample collected from the site viz. Tailbal basin involves both disturbed samples as well as undisturbed samples. The experimental program consisted of performing tests like Proctor compaction test [7], direct shear test [8] and CBR (California bearing ratio) test [9]. The first series of tests examined the behavior of dredged soil, results given in table 1 and the second series were performed on the composite soil sample with different percentage of lime content.

Table 1: properties of Dredged Material

Sieve Analysis				Shear Parameters		CBR	
Sand %	Silt + clay %	Liquid limit	Plastic limit	In-situ sample	At OMC	Unsoaked CBR	Soaked CBR
57	43	43	23	C = 2KN/m² Φ = 10⁰	C= 9KN/m² Φ = 19⁰	8.67	5.8
				C (cohesion Intercept), ϕ (Angle of Internal Friction), OMC (optimum moisture content)			

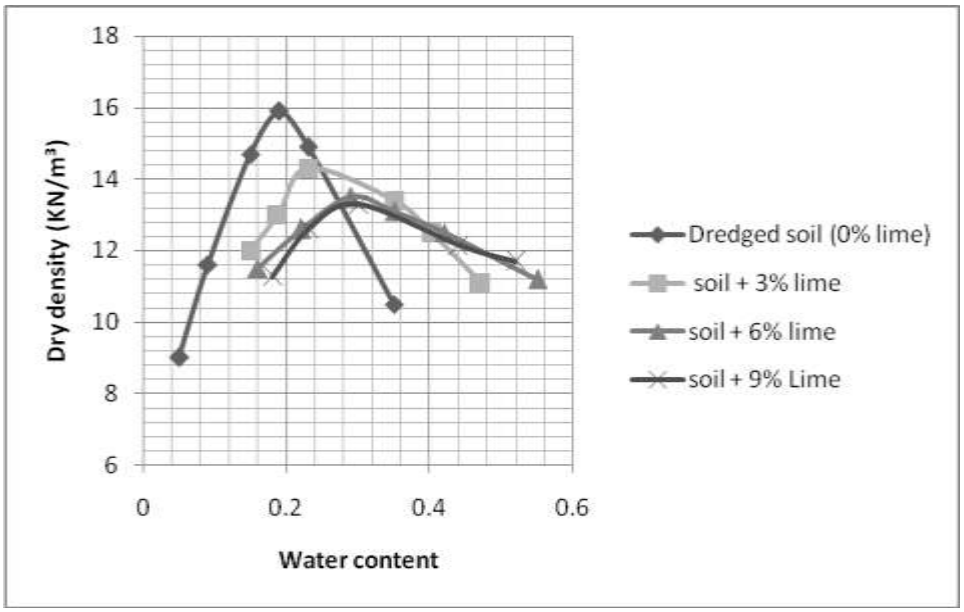
III.EXPERIMENTAL RESULTS AND INTERPRETATION

3.1 Effect of additive on compaction characteristics of dredged material.

The density of soils is an important parameter since it controls its strength, compressibility and permeability. It is observed from fig. 1 that lime treatment flattens the compaction curve therefore prescribed density can be

achieved over a much wider range of moisture contents, so relaxed moisture control specifications are possible. Also it is observed that the optimum moisture content is moved towards higher values.

Lime causes aggregation of soil particles; the agglomerated and flocculated particles of soil occupy larger spaces and hence alter the effective grading of the soil. The decrease in the maximum dry density of the treated soil is reflective of increased resistance offered by the flocculated soil structure. The increase in optimum moisture content is probably a consequence of additional water held within the flocculated soil structure resulting from lime. The lime requires more water for the pozzolanic reactions. Furthermore, the increase in OMC is due to the high surface area of lime.



Lime content	Soil + 0% lime	Soil + 3% lime	Soil + 6% lime	Soil + 9% lime
OMC (%)	19	23	29	30
MDD (KN/m³)	15.9	14.3	13.5	13.3

Fig. 1: Variation in compaction characteristics on addition of Lime

3.2 Effect of additive on shear parameters of dredged material.

The DST results shown in fig. 2 revealed that shear parameters like cohesion intercept and angle of internal friction increases in the range of 9kN/m² to 34 kN/m² and 19 degrees to 44 degrees respectively for different percentage of lime.

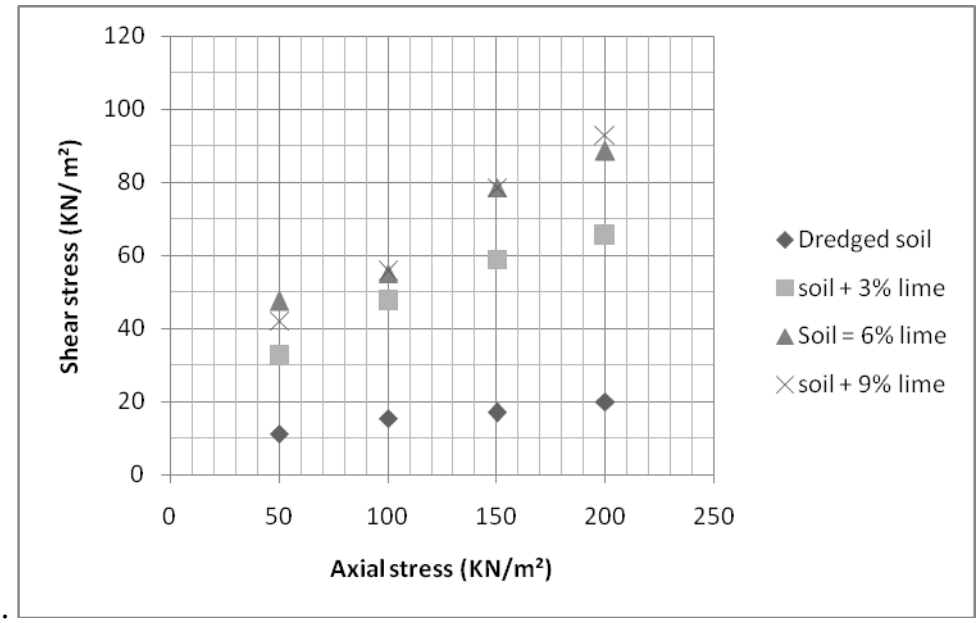


Fig 2: Direct Shesr test results of dredged soil with different lime content

The increase in shear strength parameters as shown in fig. 3, on addition of lime is attributed due to pozzolanic effect between lime and dredged soil. Hence, lime stabilization enhances the strength characteristics of dredged soil for its bulk utilization in various construction activities. Therefore, the use of pozzolanic additives in ground improvement is an effective means of waste management.

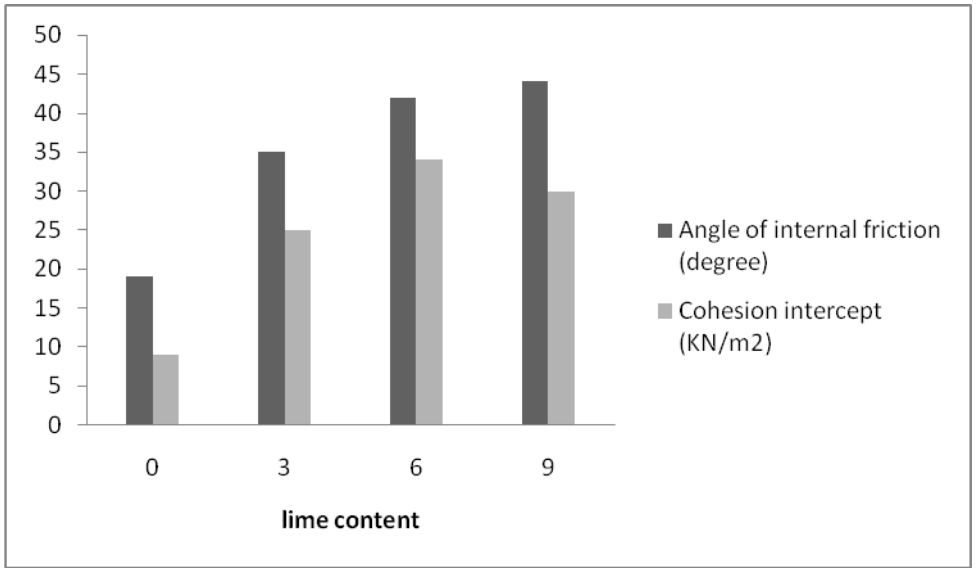


Fig 3: Variation in shear parameters on addition of Lime

3.3 Effect of additive on CBR characteristics of dredged material.

The CBR values for dredged soil are found to be 8.67% and 5.8 % for un-soaked and soaked conditions. The decrease in CBR upon soaking is due to the decreased effective stress and loss of surface tension forces. The

effect of lime on CBR characteristics under soaked conditions was studied. Additive in the form of lime shows a significant effect on load bearing nature of dredged soil as shown in fig. 4.

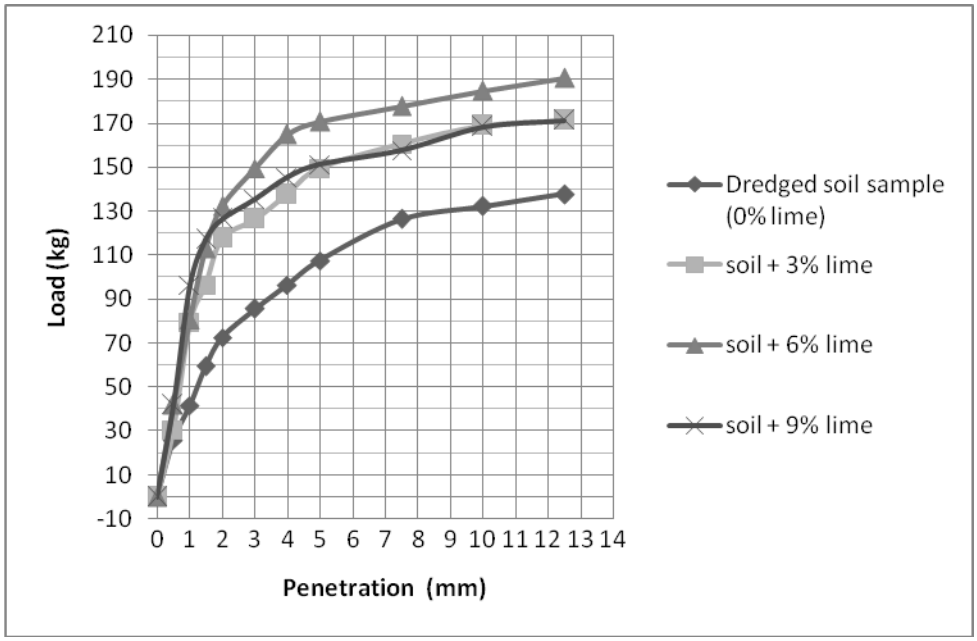


Fig 4: Variation in CBR characteristics of dredged soil on addition of lime

The CBR value of soil increases from 5.8 to 10.5. The significant increase in average stiffness modulus of soil due to lime improves the load-settlement characteristics of soil and the amount of immediate settlement would be reduced significantly. However maximum increase in CBR were seen on addition of 6% lime by dry weight of soil , increasing lime content beyond this case reduction in CBR value. The CBR of soil is contributed by cohesion and friction components of soil. However the bonding material created by the reaction between lime and soil particles is limited, high water content can prevent lime- soil contact. The considerable decrease in density can also become the cause for this reduction

IV.CONCLUSION

Following are some of the broad conclusions deduced from the present study:

1. The stabilization of the solid waste soil such as dredged soil with lime is an effective means of chemical stabilization of soils. It is seen that the engineering properties of dredged soil are significantly improved by the addition of pozzolanic materials like lime.
2. The compacted density of soil-lime mixes is low compared to untreated soil that will be beneficial since a lower density will result in lower earth pressure leading to savings. Also increase in optimum moisture content was observed.
3. Lime alters the shear strength parameters (c and Φ) of dredged soil significantly by pozzolanic reactions that increase the strength of soil. Therefore, the use of pozzolanic additives in ground improvement is an effective means of waste management.

4. With increase in lime content, California bearing ratio values are increased and hence stability of pavement increases. The maximum improvement in CBR value was seen on adding 6%lime by dry weight of soil. CBR value increases from 5.8 to 10.5

Before full-scale re-handling and reuse of dredge material is implemented, several issues need to be addressed. First, the dredging community needs to develop an extensive management strategy. This will include developing public acceptance of reuse as a beneficial product of necessary dredging activities. Second, regional re-handling facilities need to be developed. This includes space for dewatering and re-handling sediment.

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