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Geotechnical Characterization of Dredged Mud from Chilika Lake

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ABSTRACT— *The geotechnical parameters such as void ratio, porosity, particle size analysis, specific gravity, Atterberg's consistency limits, differential free swell index, compaction characteristics were studied from three different places in Chilika in the year 2013 in Southern sector only. All the three soils were rated 'Excellent to Good' to be used as soil subgrade in road construction. Silts dredged from Chilika and used for useful purposes will retard siltation and simultaneously enhance other sectors.*

Keywords— geotechnical properties, dredged mud, subgrade, siltation, Chilika.

1, INTRODUCTION

A large stretch of water where serenity is in its full swing adorns the name "Chilika". Chilika Lake (19˚43´N to 85˚19´E; 19˚43´N to 85˚19´E), a semi-closed coastal lagoon on the east-coast of India, is the largest brackish water lake in tropical Asia. The lake is a unique assemblage of brackish and fresh water ecosystem with estuarine characters [1]. Chilika was designated as a Ramsar site in 1981 under the convention on "Wetlands of International Importance". Several factors owing to anthropogenic pressures and human influence have posed serious problems [2] in the lake. The problems include siltation, change in salinity level [3], eutrophication and decrease in fish productivity [4]. The lake is reeling under the harsh impacts of siltation since years. Siltation poses a serious threat to the ecosystem of the lake. Studies have been conducted on physiochemical characteristics of Chilika Lake [5]. So far no geotechnical study has been reported on dredged soil of Chilika. The present study focuses on the geotechnical characterization of dredged mud from Chilka Lake in the line of a literature reported by NJDOT recently [6]. The basic soil parameters like void ratio, porosity, Atterberg's limits, optimum moisture content, dry density, bulk density etc. will suffice for our purpose. According to a previous study [1], the major silt load to the lake is carried by Daya, Bhargavi and Makara, the tributaries of Mahanadi river system. Approximately, 1.5 million tons of sediment per year enters the lake in the north from the distributaries of the Mahanadi River and 0.3 million tons per year

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enters the lake from the western catchment. In present analysis, samples have been collected from three places of the Southern sector of Chilika Lake and are subjected to geotechnical experimentation.

2, MATERIALS AND METHODS

The samples were collected from three different places in Chilika namely Chanakona, Barkul and Rambha shore in the month of August, i.e. the month of heavy rains.

2.1. Map Study

A thorough study on base map of Chilika catchment is carried out. According to the map study, Chilika is divided into three parts namely Southern, Central and Northern zone. Southern zone is connected with Salia River. The site for experimental investigation is selected to be the Southern zone.

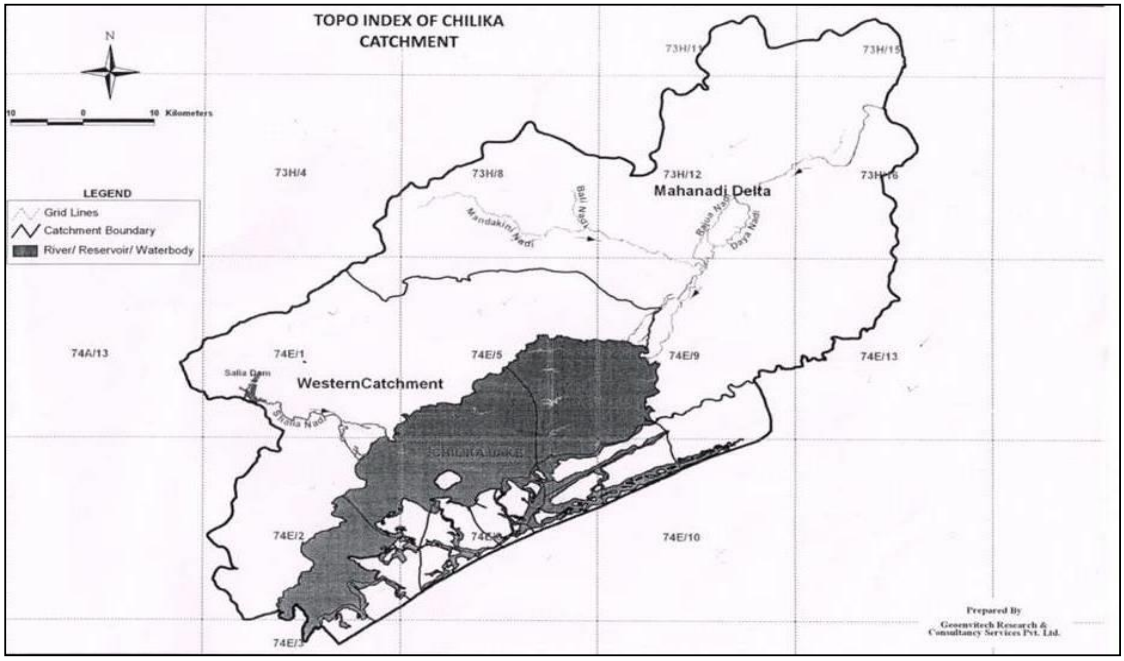

Figure.1 Map of Chilika and its catchment

2.2 Experimental Programme

All the samples are tested strictly according to relevant IS Codes in the laboratory for determination of geotechnical properties as detailed in Table.1 and Table.2.

Table.1 Geotechnical Properties and relevant IS codes

PROPERTIES	INSTRUMENTS USED	RELEVANT IS CODE
SPECIFIC GRAVITY	Density bottle	IS 2720(PART 3) - 1980
GRAIN SIZE ANALYSIS	Set of IS sieves and sieve shaker	IS 2720(PART 4) - 1985
DIIFFERENTIAL FREE SWELL INDEX	Two 100 ml capacity glass graduated cylinders	IS 2720(PART XL)-1977
LIQUID LIMIT	Mechanical liquid limit device	IS 2720 (PART 5)-1985
PLASTIC LIMIT	3mm dia needle, Glass plate	IS 2720 (PART 5) - 1970
SHRINKAGE LIMIT	Shrinkage dish, Evaporating dish, Mercury	IS 2720(PART 6) -1972
MOISTURE DENSITY CHARACTERISTICS	Standard Proctor Compaction test apparatus	IS 2720(PART VII) - 1980

Table.2 Geotechnical properties of soil samples collected from different sites

Geotechnical Properties	Chanakona site	Barkul site	Rambha shore site
Specific Gravity	2.63	2.44	2.62
D_{1O}	0.255 mm	0.1 mm	0.12 mm
D_{30}	0.56 mm	0.21 mm	0.25 mm
D_{60}	1.25 mm	0.52 mm	0.56 mm
Uniformity Coefficient	4.9	5.2	4.7
Coefficient Of Curvature	0.98	0.85	0.93
Differential Free Swell Index	47.37%	22.22%	0%
Liquid Limit	45%	34%	42%
Plastic Limit	15%	18.85%	24.92%
Plasticity Index	30.46%	15.15%	17.07%
Shrinkage limit	9.46%	26.62%	9.91%
Shrinkage Ratio	2.03	1.54	1.91
Volumetric Shrinkage	77.85%	24.67%	72.47%
Linear Shrinkage	17.42%	7.08%	16.62%
Flow Index	13.52%	7.45%	7.27%
Toughness Index	1.1	4.6	2.3
Bulk Density	1.89gm/cm^3	1.94 gm/cm^3	1.83 gm/cm^3
Maximum Dry Density	1.57 gm/cm^3	1.755 gm/cm^3	1.54gm/cm^3
Optimum Moisture Content	20.75%	10.55%	18.76%
Void Ratio, (e)	0.658	0.39	0.7
Porosity, (n)	0.4	0.28	0.42

3, DISCUSSION ON EXPERIMENTAL RESULTS

3.1 Specific Gravity

Barkul soil has a specific gravity of 2.44 which indicates silt with organic matter or clay which is understood as a lot of tourists visit Chilika via Barkul. It is lighter as compared to other two soils samples from Chanakona and Rambha shore. Rambha shore and Chanakona soil samples exhibit a specific gravity of 2.62 and 2.63 respectively. This implies the presence of Quartz sand.

3.2 Grain Size Analysis

All the three samples from Chanakona, Rambha Shore and Barkul are found to be silty or clayey sand and have a general rating of 'Excellent to Good' to be used as a sub grade according to AASHTO classification. These soils can be excavated and dredged to be used in the transportation system to make a better roadway network for the would-be international tourist site as proposed by World Bank.

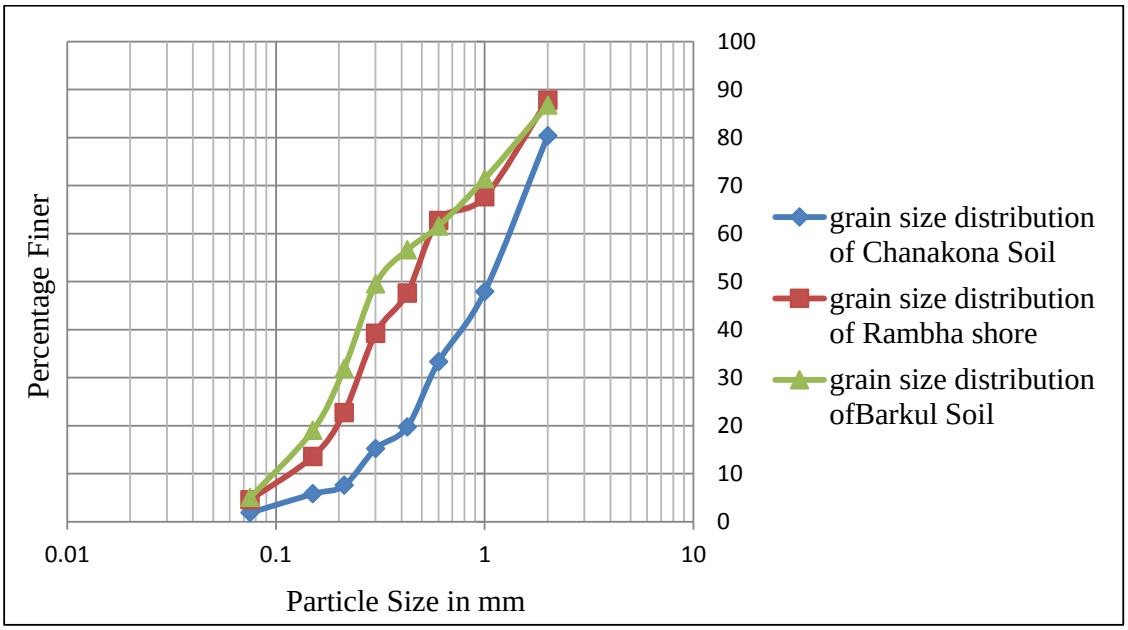

Figure.2 Particle size distribution

3.3 Differential Free Swell Index

The differential free swell of Chanakona soil is 47.37% which indicates that it possesses a high degree of expansion. The differential free swell of Rambha shore soil was determined to be 0% which indicates that it possesses a low or negligible degree of expansion. The differential free swell of Barkul soil was determined to be 22.22% which indicates that it possesses a moderate degree of expansion.

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3.4 Flow Index

Flow index of Chanakona soil sample is the highest. So, it possesses the lowest shear strength. This implies that Chanakona soil sample loses its shear strength at a faster rate with an increase in water content as compared to Rambha shore and Barkul soil sample.

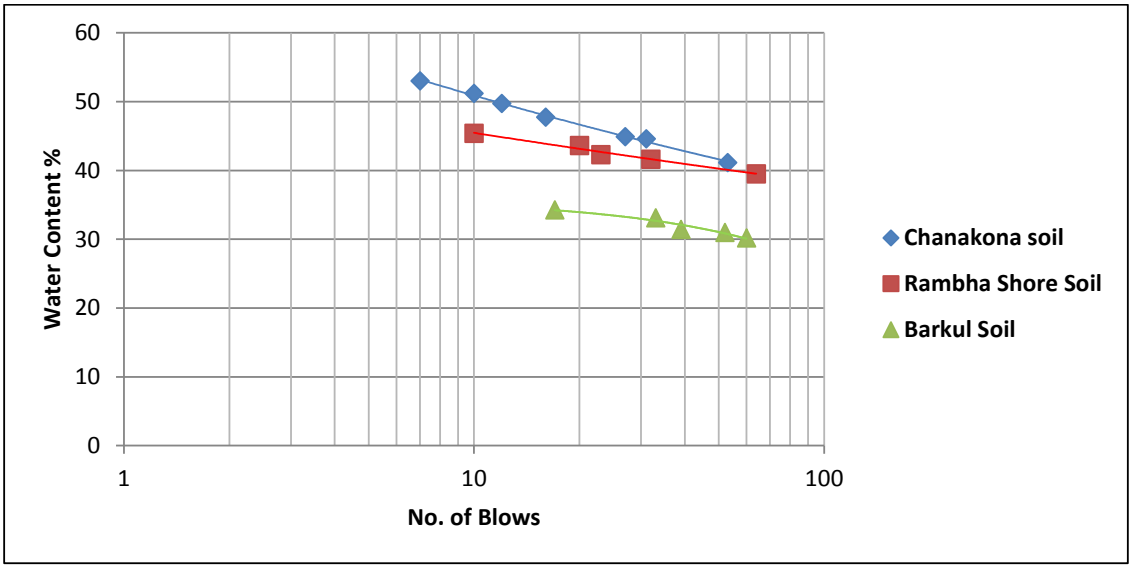

Figure.3 Flow curves

3.5 Compaction Tests

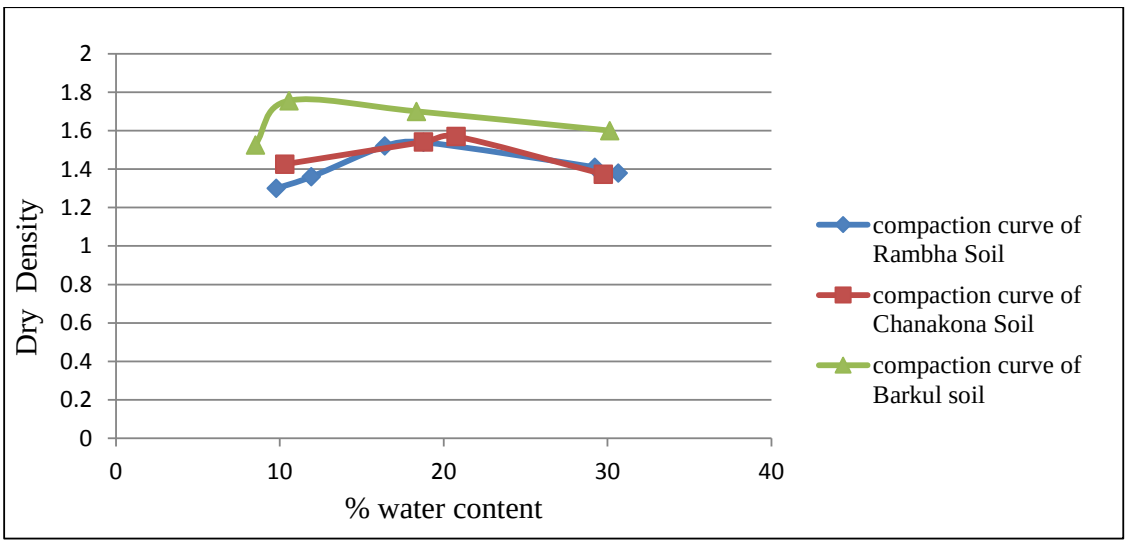

Figure.4 Compaction curves

Results show that Chanakona soil possesses highest optimum moisture content whereas Barkul soil possesses highest maximum dry density.

IV. CONCLUSION AND FUTUREWORK

It is true that Chilika is undergoing the problem of siltation. Dredging silt from Chilika and utilizing the dredged silt in a useful way is a good way to deal with siltation. As discussed earlier, dredged mud from Chilika Lake is good to be used as sub-grade for road work. Some other uses can be brought to view by study through improved techniques like X-Ray Diffraction, Atomic Absorption Spectra, and trace element analysis by External PIXE.

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BIOGRAPHY

The present study is a part of the final year project work of B.Tech programme conducted by first five authors under the guidance of the sixth author, the Head of Civil Engineering Department. The work is on siltation problem of Chilika Lake and its remedial measures.