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Review on Study Testing and Evaluating Dredged Material and Solid Waste for Upland Beneficial Uses

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Abstract: *Dredged soil is a solid waste generated from dredging of river/lake/pond/channel etc., which possesses low bearing capacity and high compressibility. Large amount of soft soil deposits of solid waste generated by the dredging of the flood spill channel as a part of its regular maintenance in Srinagar City. Concern over the environmental effects of dredging, disposal and the increasing unavailability of suitable disposal sites, has put pressure on characterization of the material. Although these dredged soils are generally considered as waste due to the poor engineering properties, this material can be valuable resource for many practical purposes, such as fill material, landscaping, agriculture, reclamation, creation of islands, constructing wetlands for water quality improvements, wildlife habitat wetlands, landfill covers, subgrade construction and amongst others. Disturbed soil specimens were collected from different sites of the flood channel and various soil tests like gradation, specific gravity, consistency indexes, light compaction, unconfined compressive strength, and direct shear stress were conducted. Specimens for various laboratory tests were prepared at 0.95* γ_{dmax} *and corresponding water content on the dry side of optimum. The results of three samples were compared and the weakest soil specimen was selected for treatment. The silty soil was added to the dredged soil in varying percentage of 20%, 40%, 60%, and 80%. The tests were conducted with the stabilized soil at these percentages and the effect of stabilization was analyzed. CBR samples of stabilized dredged material with silty clay soil were tested for un-soaked and soaked (soaked for 4 days) conditions. CBR values increased with the increase in normal silty clay soil content in the dredged soil. It was observed that 60% of silty soil is an optimum amount to maximize the CBR value of the dredged soil. Thus, stabilization of the dredged soil showed a tremendous improvement in its engineering properties and hence, using dredged soil has two-fold advantage. First, to avoid the environmental problems caused by the large-scale dumping of dredged soil and thus to help the sustainable development of the environment around the flood spill channel. Second, to use the dredged material effectively as the subgrade construction material.*

***Keywords:* Dredged, Dredged Material, compressive strength, and direct shear stress, CBR test.**

1. INTRODUCTION

In Civil Engineering practice, soil is used as construction material for Roads, Airfield, Pavements, Dams and Embankments etc., or as Fill Material behind Retaining Walls and for Reclamation of low-lying areas. Soil sub-grade is an integral part of the Road Pavement as it provides support to the pavement structure. As it provides support to the pavement as its foundation, and should possess sufficient stability under adverse climatic and loading condition. When soil is used in embankment construction, in addition to stability, incompressibility is also important as differential settlement may cause failures. Soil is used in its natural form (Gravel and Sand) or in a stabilized layer for pavement construction. Soil is also used as a binder in Water-Bound Macadam layers. The foundation of other Cross-Drainage structures (Culverts, Bridges and Retaining Walls) rests on the Soil and their stability depends on the soil strength. Soil is therefore, considered as one of the principal highway materials. Knowledge of soil properties is necessary to select the embankment material, pavement structure, drainage system and foundation of structures. Dredging of the River bed and Flood Channels generates dredged soil in large quantity posing serious health and environmental problems. Concern over environmental effects of dredging, disposal 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. Depending on the type of environment, excavated material may comprise of gravel, sand, silt or soft clays. On the basis of its characterization, it may be put to various uses such as fill material, sub grade construction, reclamation, landscaping, agriculture, covers for landfills, constructing wetlands for water quality improvement, bank stabilization, creation of islands and amongst others. . In many cases, dredged material consist of a mixture of sand and clay fraction and other organic matter which require some type of separation process. Dewatering may also be required because of high water content. Depending on sediment type and processing requirements, dredged material may be used as a concrete aggregate (Sand or Gravel); Ceramics - such as a tile (Clay); Pellets for insulation or light weight backfill or aggregate (Clay); and raw material for the production of Riprap or blocks for the protection of dikes and slopes against erosion (Rock, mixture).

A. DREDGING

Dredging is the removal of sediments and debris from the bottom of lakes, rivers, harbours, and other water bodies. It is a routine necessity in waterways around the world because sedimentation the natural process of sand and silt washing downstream gradually fills channels and harbours' excavation process commonly referred to as dredging involves the removal of sediment in its natural (new-work c construction) or recently deposited (maintenance) condition, either mechanically or hydraulically. After the sediment has been excavated, it is transported from the dredging site to the placement site or disposal area. This transport operation, in many cases, is accomplished by the dredge itself or by using additional equipment such as barges, scows, and pipelines with booster pumps. Once the dredged material has been collected and transported, the final step in the dredging process is placement in either open-water, near shore, or upland locations. The choice of management alternatives involves a variety of factors related to the dredging process including environmental acceptability, technical feasibility, and economic feasibility of the chosen alternative.

Figure Dredging

- ## Need for Dredging

Dredging is essential for navigation, port development, protection of the environment and safety against flooding. Dredging of waterways creates large volumes of dredged material. This material is basically a valuable resource which can be used although much of it is currently disposed. There are a number of dredging activities, which may give rise to the need to relocate or dispose of sediments. These include:

a) Capital Dredging:

For navigation, to enlarge or deepen existing channel and port areas or to create new ones; and for engineering purposes; e.g., trenches for pipes, cables, immersed tube tunnels, removal of material unsuitable for foundations, removal of overburden for aggregate extractions.

b) Maintenance Dredging:

To ensure that channels, construction works, etc., are maintained at their designed dimensions.

c) Clean up Dredging:

Deliberate removal of contaminated material for human health and environmental protection purposes.

B. Dredged Material

- **Open Water Disposal**

Open water disposal refers to the placement of dredged material in rivers, or ocean or any other water body. This disposal option has become unacceptable in the face of pertinent legislative action and public opposition. Recently, an evaluation method of open water disposal has been suggested which is based on a stress factor (material specific effects) called Load Potential (LP) and ecological elasticity factor (available water reaction) called Tolerance Potential (TP). As long TP is greater than LP, open water disposal will maintain stable condition without long term change or damage of the environment.

- **Confined Disposal**

Confined disposal is the placement of dredge material within dike near shore or in upland confined disposal facilities (CDF). Confinement or retention structures enclose the disposal area above any adjacent water surface, isolating the dredge material completely. It is enclosed CDF area, which distinguishes this disposal method from others such as unconfined land or Contained Aquatic Disposal (CAD). Confined disposal facilities have to eliminate all potential escapes routes of the contaminants: effluent during placement, surface runoff etc.

ii. LITERATURE REVIEW

1) Y. T. Kim et. al. (Journal of Materials in Civil Engineering Vol. 23, Issue 9, September 2011), investigated the engineering characteristics of rubber-added lightweight soil (RLS), which consists of dredged soil, crumb rubber, and bottom ash in Republic of Korea. RLS is considered to be environmentally friendly because it provides a means to recycle dredged soil, rubber, and bottom ash. Several kinds of specimens were prepared with seven different water contents (140 200% at 10% intervals) and five different rubber contents (0 100% at 25% intervals by dredged soil weight) and subjected to flow testing to investigate the flow-ability of the mixtures. Unconfined compression tests were also carried out to evaluate the mechanical properties of RLS, including bulk unit weight, strength, and secant modulus.
2) Helene Trembley et. al. (Canadian geotechnical journal, 2002), studied the effect of cement when it is added to an organic soil in Canada. It appeared that some of the organic compound delayed or inhibited the hydration process of cement, while others did not affect the reaction at all. Thirteen different organic compounds were added to the soil and then treated with 10% cement. To access the cementing process, undrained shear strength was measured on different specimens. The results indicated that the organic acids producing a pH lower than 9 strongly affected the development of cementing products and almost no strength gain was noted. Also, oils and hydrocarbons, which are insoluble in water, delay the cement hydration but do not affect the final strength. Thus, the pH value and the SO_4 concentration are good indicators of cementing effectiveness of the treated specimens.
3) Farid Sariosseiri et. al. (volume 104, issues 1-2, Feb-2009, pages 119-125), studied the use of Portland cement in the modification and stabilization of soils in the state of Washington, USA. Cement was added in the percentages of 2.5, 5, 7.5 and 10%, by dry weight of the soils. To determine the drying rate of the soil various laboratory tests were performed like, Atterberg s limits, compaction characteristics, unconfined compressive strength, and shear strength. The results showed significant improvement in the drying rate, workability, unconfined compressive strength and shear strength.
4) Dong Xing Wang et. al. (2012), studied the effects of cement and lime on the stabilization of dredged fine sediments in France, as a potential use for road construction. The liquid limits of samples treated with lime or cement show an initial increase with the addition of 3% binder, followed by an almost constant value with 6% binder and a gradual decrease with 9% binder. The plastic limit increases as a result of the increase in binder content, which causes a reduction in plasticity index. The maximum dry density of solidified sediments decreases with binder content until the binder compensates for the larger spaces, whereas the optimum moisture content.
5) Prakash et. al. (2016), studied that the use of quarry dust as a stabilizing agent on dredged marine sediments in India can increase its strength to a great extent. Attempts were made to stabilize the dredged material for the different applications such as embankment construction, road construction and for landfill. The stabilization of the dredged marine sediment was done by using quarry dust. Quarry dust is a waste product generated from the aggregate production could replace some proportion of soil for the improvement of geophysical properties of the soil. The addition of quarry dust improves the properties of dredged marine soil. The maximum dry density improved by addition of each 10% of quarry dust. Addition of quarry dust leads to the increase in the maximum dry density and decrease in the optimum moisture content. Compared to untreated soil the CBR value found to be increased by the addition of quarry dust. The addition of quarry dust increases the CBR value from 2.97 to 5.92.

The increase in CBR value shows the suitability to use as a pavement material. According to IRC 37-2001, sub grade should have a minimum CBR value of 5.9% to provide a pavement of total thickness 615mm.

6) Yusuf et. al. (2012), studied the effect of Portland cement when used as a stabilizing agent on dredged marine to increase the strength properties. The cement addition to the dredge sediments increases the CBR value. The cement stabilized sediments can be used for different applications especially for the road sub grade construction. The addition of 20% cements results in the increase in strength of the dredged material suitable for the engineering applications.

iii. OBJECTIVE OF WORK

The principal objective of Geotechnical testing is to know the properties and behaviour of soil as an engineering material. Soil is a natural product. It exhibits inherently variable and complex character. The performance is greatly affected by the natural environmental condition imposed by construction of structure. The main objective of my project work is summarized as below:

- ❖ To study the various Geotechnical parameters of the dredged material from Flood Spill Channel and Srinagar City Soil.
- ❖ To study the effect of Srinagar City Soil (silty soil) on some physical and engineering properties of the dredged material.
- ❖ To determine the feasibility of Srinagar City Soil (silty soil) stabilized dredged material from Flood Spill Channel for use in road construction.

Hence, using dredged material as source has a two-fold advantages. First, to avoid the tremendous environmental problems caused by large scale dumping of dredged material and second, to use it for various Engineering applications as Road construction material.

iv. CONCLUSIONS

- ❖ Dredged Soil consist of uniformly graded silt containing Organic content with poor fill material characteristics.
- ❖ Specific Gravity of untreated Dredged Soil was very low and this Specific Gravity is attributed to poor gradation of Dredged Soil. Specific Gravity of dredged material increases with addition of City Soil Sample.
- ❖ Liquid Limit of Air-dried samples is more than 30% of Oven-dried Sample which indicate the presence of organic content. Grain size distributions of the dredged soil were altered by the addition of the City Soil Sample. The sand fraction increased where the clay and organic fractions decreased with increasing amount of admixture.
- ❖ Dredged Material can be recommended as fill material for low lying areas, land improvement and agriculture use.
- ❖ Addition of City Soil to Dredged Soil with increment of 20%, there is gradual decrease in OMC value and increase in MDD values. The decrease in moisture content may be attributed due to change in soil matrix by adding relatively coarser material and also increases the unit weight of composite specimens due to higher specific gravity for City Soil Sample.
- ❖ The structure of the soil particle changes from flocculated to a dispersed structure as the water content is increased from the dry of optimum to the wet side of optimum.
- ❖ A proper mix proportion improves the CBR value. It has been observed that 60% of City Soil is optimum amount required to maximize the CBR of the Dredged Soil.

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