Dredged material properties and its use as soil subgrade: A Review

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Abstract

This study presents the results of experimental study carried out to investigate the Subgrade geotechnical properties of dredged material from Wular Lake, one of the largest fresh water lakes in Asia and largest flood basin of Kashmir in the northern Bandipora district 34 km north of Srinagar. Every year thousands of tons of silt is deposited in the lake which is constantly decreasing its depth and water holding capacity. Dredging the heavily silted Wular Lake is a key to save it from dying. Its dredging operations generate a large quantity of dredged material posing serious health and environmental problems. Concern over environmental effect 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 applications. Its mineralogy and geotechnical properties qualify it for various uses. Therefore, comprehensive laboratory and field investigations were conducted to determine the engineering properties of the dredged material. The results show that dredged material can be effectively used in bulk as a resource for various applications. Thus our study aims at to determine the properties of the material and is this material suitable for subgrade of roads.

INTRODUCTION

Wular lake is one the largest fresh water lakes in Asia. It is sited in the Bandipora district. Wular Lake is located 34 km northwest of Srinagar city at an altitude of 1,530 m AMSL between 34°20’ N latitude and 70°24’ E longitude. It is elliptical in shape with a maximum length of 16 km and breadth of 7.6 km. The lake is surrounded by high mountainous ranges on the northeastern and northwestern sides, which drain their runoff through various Nallahs, prominent being Erin and Madhumati. On the eastern and southern sides are the low lying areas of Sonawari which used to get inundated almost every year until numerous criss-crossing embankments were constructed along River Jhelum.

1.4 OBJECTIVES OF THE WORK:-

Our Project Objectives may be summarized as:-

- To study the various geotechnical parameters of the dredged material from Wular Lake to check whether it is suitable for road subgrade.
- To determine the suitability of the material dredged from Wular-lake for different uses like filling and foundations.
- To determine the feasibility of the material dredged from Wular-lake for use in road construction.



FIG 1 . Study site

LITERATURE REVIEW

DREDGED MATERIAL AND ITS SOURCES:-

Dredging is simply the removal of sediments from a body of water that have accumulated due to upland

erosion in order to maintain a desired depth, as in a reservoir, lake, dam, shipping berth, navigation channel. Dredged materials exhibit properties similar to those of undisturbed native soil and rock materials in a subaqueous environment, but when excavated, removed, remoulded, or redeposited, the properties change accordingly as the original material structure changes. High water contents, low dry densities, and low shear strengths typify remoulded and deposited fine-grained dredged materials. Dredged material is categorized into various sediment types such as- Rock, gravel and sand, consolidated clay, silt or soft clay and a mixture of rock, sand silt and soft clay. Rock may range from soft marl like sandstone and coral to hard rock like granite and basalt. Depending on its size and quantity rock can be a valuable construction material. Gravel and sand are perhaps the most valuable resource and are routinely used for beach nourishment, wetland restoration and many other purposes.

Consolidated clay, if the water content is low, can be used for engineering purposes. Silt and soft clay usually come from maintenance dredging, are rich in nutrients and thus are good for agricultural purposes such as topsoil and for wildlife habitat development. Mixed materials are somewhat more restricted in use options but may still be used for filling, and improvement and topsoil. Using dredged material as a resource is important, one could almost say urgent, because use – rather than disposal has broad societal, environmental and financial benefits. It contributes to global sustainability. The potential uses for dredged material depend on the type of dredged material, where it is dredged, how it is dredged and its overall acceptability. Two broad categories of proposed uses are often distinguished: Engineering uses and environmental uses.

Engineering uses of dredged material include: Construction including landfill and foundation materials; Isolation of contaminated sites; Flood and coastal protection, such as beach nourishment; Land improvement; and Placement on riverbanks. Environmental enhancement using dredged material includes: Habitat creation and improvement; Water quality improvement; Aquaculture; Agriculture; Recreation; Sustainable relocation; and pit filling. In both cases, criteria are to be established that ensure that extensive testing is done for suitability of materials, that the potential use site is in reasonable proximity to where the dredging is planned and that a thorough physical and chemical evaluation is done. Beneficial use of dredged material is an integral and necessary part of the dredge material management process. Dredged material can be beneficially used in upland, wetland, and aquatic environment.

TESTING PROCESS:-

Following tests were performed in order to characterize the soil samples:-

- Liquid Limit: The liquid limit (LL) is the water content at which a soil changes from plastic to liquid behavior. At this limit, the soil possesses a small value of shear strength, losing its ability to flow as a liquid. In other words, the liquid limit is the minimum moisture content at which the soil tends to flow as a liquid.
- Plastic Limit: Plastic limit (PL) is the arbitrary limit of water content at which the soil tends to pass from the plastic state to the semi-solid state of consistency. Thus, this is the minimum water content, at which the change in shape of the soil is accompanied by visible cracks, i.e., when worked upon, the soil crumbles.
- Plasticity Index: Plasticity Index (PI) is the range of water content within which the soil exhibits plastic properties, that is, it is the difference between liquid and plastic limits. **Plasticity Index (IP) = Liquid Limit(WL) -Plastic Limit (WP)**
- Specific Gravity: Specific gravity of soil solids is defined as the ratio of unit weight of solids to the unit weight of water at the standard temperature (4°C).
- Sieve Analysis: About 1kg of soil was taken and it was washed thoroughly with water on 75 micron sieve ,soil retained on sieve was dried and weighed and used for sieve analysis .These dried soils were passed through stack of sieves like 4.75mm,2.36mm,1.18mm,600µm,300 µm,150 µm, 0.75 µm.
- California Bearing Ratio Test: The CBR is a measure of resistance of a material to penetration of standard plunger under controlled density and moisture conditions. The test procedure should be strictly adhered if high degree of reproducibility is desired. The CBR test may be conducted in re-

moulded or undisturbed specimens in the laboratory. The test has been extensively investigated for field correlation of flexible pavement thickness requirement. Briefly, the test consists of causing a cylindrical plunger of 50mm diameter to penetrate a pavement component material at 1.25mm/minute. The loads, for 2.5mm and 5mm are recorded. This load is expressed as a percentage of standard load value at a respective deformation level to obtain CBR value.

- This test is performed to determine the water (moisture) content of soils. The water content is the ratio, expressed as a percentage, of the mass of "pore" or "free" water in a given mass of soil to the mass of the dry soil solids. This test is done as per IS 2720 (Part II) – 1973. Moisture content determination

- In-situ dry density determination

This test is done to determine the in-situ dry density of soil by core cutter method as per IS: 2720 (Part XXIX) – 1975.

- Hydrometer analysis

Specifically, this experiment deals with silts and clays, which were saved from the previous experiment, which separated soil particles mechanically using sieves. This method further separates fine soil particles so that a complete grain size distribution curve can be produced by the end of this experiment. From this curve, many important aspects of the soil can be determined and a general classification of the soil can be made.

- Light compaction test

This laboratory test is performed to determine the relationship between the moisture content and the dry density of a soil for a specified compactive effort. The compactive effort is the amount of mechanical energy that is applied to the soil mass. Several different methods are used to compact soil in the field, and some examples include tamping, kneading, vibration, and static load compaction. This laboratory will employ the tamping or impact compaction method using the type of equipment and methodology developed by R. R. Proctor in 1933, therefore, the test is also known as the Proctor test. Two types of compaction tests are routinely performed:

(1) The Standard Proctor Test, and (2) The Modified Proctor Test.

- Direct Shear test

The primary purpose of this test is to determine the unconfined compressive strength, which is then used to calculate the unconsolidated undrained shear strength of the clay under unconfined conditions. For soils, the undrained shear strength (cu) is necessary for the determination of the bearing capacity of foundations, dams, etc.

σ = $(weight\ of\ yoke + normal\ load\ )/area\ of\ the\ shear\ box$

- Unconfined compressive test

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Sensitivity = $(undisturbed)/qu(remoulded)$

If failure angle (α) has been measured, calculate the angle of internal friction

$\emptyset u = (\alpha - 45) \times 26.$

Calculate the value of cohesion Cu

Cu = $qu/2$ if sample is fully saturated

Cu = $qu/2tan\alpha$ if sample is partially saturated

- Organic content determination

This test is performed to determine the organic content of soils. The organic content is the ratio, expressed as a percentage, of the mass of organic matter in a given mass of soil to the mass of the dry soil solids. This test is done as per ASTDM D 2974

Aim of work

This study aims to determine the various soil properties of the dredged material from the wallur source and find the effective use of that material in the subgrade of the road.

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