ALTERATION OF DREDGED MATERIAL FROM JHELUM FLOOD SPILL CHANNEL USING CEMENT AND LIME AS BINDER FOR ITS POTENTIAL APPLICATION IN SUB-GRADE

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***ABSTRACT*: In present times, dredged material has attained such a position in construction industry that it is being considered more of a resource than a waste material. Attempts are being made all over the world to utilize this resource as a construction material in one way or the other. The dredging of Jhelum Flood Spill channel will also result in the availability of large quantity of dredged material. Therefore, initiatives must be taken to utilize this resource. Investigations for its characterization and steps to access the most probable methods for improvement of its properties for its application in construction industry are of immense necessity. Stabilization is one such technique to improve the properties of dredged material using different binders.**

The present study consists of three phases. The first phase involves the sampling of dredged material from Jhelum flood spill channel bed. The second phase will involve the characterization of dredged material with regards to its physical and strength properties. The third phase will involve the stabilization of dredged material at its optimum moisture content using different dosages of cement paste/slurry and lime and cured for 3 days. The stabilization will then be tested for its unconfined compressive strength and CBR values and resulting trends will be plotted for interpretation.

Introduction

The most devastating flood occurred in September 2014 which resulted in intolerable damage to life, property and also economy activities were disrupted. The present capacity of flood spill channel is significantly less than its design capacity. This is mainly due to unplanned urbanization and encroachments along the banks of river Jhelum. There is a need to prevent such hazards and Govt. of Jammu and Kashmir has taken necessary steps against the same. One of the proposal was dredging of Jhelum river and its flood spill channel. Dredging facilitates water flow and increases the carrying capacity of river but it also creates large quantity of dredged material. Now there is a need for proper disposal of the dredged material.

Dredged material is a valuable resource and has attained such a position in construction industry that it is being considered more a resource than a waste material. The use of dredged material has a major contribution to make sustainable development and can reduce the quantities of primary resources needed for activities such as construction and habitat creation.

Dredged material from flood spill channel is naturally accumulated sediment, mostly alluvial soil. Alluvial soil usually consists of sand, silt, clay or there combination. The potential use of dredged material in various engineering works depends upon the type and location of the material. There are broadly two categories of proposed use i.e., engineering use and environmental use. Engineering use involves construction like landfill and foundation materials. Environmental use includes water quality improvement, Agriculture, Aquaculture etc. Beneficial use of dredged material is thus an integral and necessary part of dredge material management process.

The dredging of Jhelum flood channel has also resulted in large quantity of dredged material. Therefore, initiatives must be taken to utilize this resource. Due to rapid urbanization and increase in population, there is scarcity of good construction sites for the construction of various engineering projects. Therefore, investigations for characterization of dredged material and steps to access the probable methods for the improvement of its properties for its application in construction industry are of immense necessity. Stabilization is one such technique to improve the properties of dredging material using different binders and is often economical as compared to other ground improvement methods.

BACKGROUND

In recent times, various studies exploring the potential of dredged material for use as a material for construction purpose have been conducted in different parts of the world. S. Nontananandh et al, [1], carried out the mechanical and chemical stabilization of dredged materials obtained from 2nd waterway of Bangkok seaport in Thailand for exploring its use as bottom liners for landfills. The Dredged material was found to have extremely high water content. Subsequently, it's dewatering and stabilization with cement

was carried out in order to explore its effect on the strength and permeability characteristics of the dredged material. It was found that the stabilized material exhibited desirable strength and permeability properties as a liner. The strength of the stabilized dredged material was found to be dependent not only on the cement content but also on the initial water content at the time of mixing.

Hua Yu et al, [2], worked on the stabilization of dredged material obtained from CDF located at the south end of Milwaukee Harbor in U.S for its use as sub-base or subgrade fill in roadway construction. Since the dredged material was found to be poorest earthwork material, therefore its stabilization with fly ash was carried out in order to find its effect on undrained shear strength, unconfined compressive strength, compaction and durability characteristics of dredged material. It was found that the stabilized material opted desirable strength, compaction characteristics and durability properties. The UU shear strength and unconfined compressive strength depended on fly ash content and curing time. It was also concluded that using fly ash to stabilize dredged material offers a feasible and effective way of using high volumes of dredged materials and thereby reducing the burden of storage and disposal of fly ash.

A. Prakash, A. Paul, [3], studied the stabilization of marshy soil obtained from Vallarpadam, Ernakulam, Kerala for reusing it as sustainable material in embankment construction, road construction and for landfill. The dredged material was found to have high water content, low shear strength and high compressibility. Subsequently, its stabilization was carried out with Quarry dust to modify to modify the geophysical properties of the dredged material. It was found that the stabilized material acquired the desirable strength, CBR value and also maximum dry density for its suitability to be used as pavement material.

El – Shinami and V. Kramarenko, [4], carried out the stabilization of dredged material obtained from Harghada coast Red sea, Egypt for exploring its use in tidal flat areas, in various reclamation projects, and as subgrade of road pavements. The dredged material can't be directly used for construction activities because of its poor geophysical properties such as high water content, presence of organic matter and salt. Subsequently it's stabilization with Portland cement was carried out to improve its strength to be used for various purposes. The strength of stabilized material depends not only on cement content but also on the curing time.

Walid Maherzi et al.,2014,[5], working under a large Research European Interreg IVA program, SETARMS, conducted the physical and geotechnical characterization of grudged material sampled from different French ports for its suitability as sub-grade layer. Typical geotechnical laboratory investigations like Particle size distribution, Water content determination, Atterberg limits determination, Compaction test were conducted. Initial water content has been observed to be very high and need for dehydration has been observed to be fine grained and recommended to be stabilized with quick lime and cement for establishing its suitability as a sub-grade material. The studies conducted were thus confirmed to explore the suitability of dredged material for road construction only. Since the material turned out to be fine grained and less permeable, it could have been recommended for use in impervious cores of zoned earthen dams and also for compacted canal lining and as clay liner material.

C. Sheehan et al., [6], in their investigation for beneficial use for dredged material in Ireland, employed the physical and chemical tests to establish the suitability of dredged material from three ports. It has been observed that the material from one of the ports was coarse grained but contaminated and soil washing has been recommended in order to clean the coarse material and separate the small portion of contaminated fine material for further treatment. The clean portion then could be used for land reclamation. Although, it could have been also recommended for use as aggregate in concrete. The second sample was observed to be fine grained and clean and it has been recommended for use as core material in geotubes for a breakwater or coastal protection device. The samples from third port has been observed to be different at different locations with the material being fine grained at one location and being primarily sand at another location, little downstream. The material obtained from this port has been recommended for top soil production. In another study, samples of processed Construction & Demolition waste and dredged material were collected from locations in Cork City and Cork County to characterize the materials. The C&D samples were obtained from stock piles at two recycling centres in Cork City and the dredged samples by grab sampling, from the bucket of a dredger or from mudflats at various locations in Ireland. Ten samples of waste material were tested, 3 C&D samples and 7 dredge samples. One additional sample of a typical clay which was in use as a landfill liner were also tested for Particle size distribution, Consistency limits, Organic content, Light compaction, Particle density, and Hydraulic conductivity. The analysis of the samples of the C&D waste and the dredged material indicated that it would be technically feasible to prepare a composite sample from the two materials which would satisfy the requirements of the compacted clay liner. Multiple combinations both of samples and proportions of samples were examined, initially by analysis of the particle size distributions. The methodology used to achieve a composite sample were to analyze the particle size distribution produced by selected proportions of the C&D samples and the dredge samples. The composite sample which best fit the particle size distribution curve of the landfill liner sample resulted from a combination of 30% of one C&D sample and 70% of one dredge sample. A suitable sized sample of this composite material was then prepared and geotechnical tests, including hydraulic conductivity tests were undertaken and it was found suitable to be used as clay liner material. Thus, a step was taken to improve the property of dredged material by the addition of a waste material in order to make it suitable for a particular purpose. The study thus hints at the possible ways to improve a dredged material for some particular application without just discarding it right away.

Evangelin Ramani Sujatha et al., 2013, [7], evaluated the geotechnical parameters of material obtained from Kollidam river bed in Tamil Nadu. In this study, attempts had been made to characterize the soil and supplement its geotechnical properties with its mineralogical composition. Clay minerals were identified from X-ray Diffraction analysis. Strength of material in relation to the change in water content and compressibility behaviour under adverse hydrological conditions has been studied. Consistency limits

and specific gravity were determined both for oven dried and air dried samples and little difference was observed in the results for oven and air dried samples, suggesting very little amount of organic content. The soil has been classified as CH-CI (highly to moderately compressible clay) in-spite of the presence of large portion of silt due to its high plasticity index. The consistency limits were in line with the mineralogical composition (XRD analysis). Eventually the soil had been recommended for use as fill material. It must be noted that an additional investigation in the form of X-ray diffraction analysis has been made in this study and it supported the characterization of soil in a genuine way.

Thus, it can be concluded that laboratory geotechnical investigation form an integral part of geotechnical characterization of dredged material. More advanced techniques have been used in the material characterization but just to supplement the results obtained from typical laboratory tests. Also, there are least chances that the dredged material cannot be used for any engineering purpose. In majority of the cases, it has been found that the dredged material has the potential for its beneficial use in one way or the other.

Objectives:

The objectives to be achieved during the execution of the project can be summarized as below:

- To explore the potential application of mass stabilization for shallow mixing of the dredged material from Jhelum Flood Spill Channel with Cement and Lime as binder
- To explore the influence of binder content on the strength characteristics of the dredged material
- To compare the results obtained by stabilizing the Dredged material with cement against the lime stabilization.

Dredged material and its classifications

The objective of soil classification is to sort out the soils into groups each of which would show similar behavior. Any soil classification system must provide us with information about the probable engineering behavior of a soil. This means that once soil is classified, it should be possible to grade the soil for its suitability for specific engineering project. However, a soil classification system does not eliminate the need for detailed soil investigation and for testing for engineering properties. It can at best give some fair idea about its engineering behavior. Thus, it is proposed to classify the material retrieved from Jhelum flood spill channel bed, in order to acquire some fair idea about its suitability for various constructional purposes. There are various classification systems available which can be used to classify dredged material like Unified Soil Classification System (USCS), American Association of State Highway and Transport Officials (AASHTO) System, and Indian Standard Soil Classification System (ISSCS), but in the present study, its proposed to employ Indian Standard Soil Classification System(ISSCS).

Conclusion:

From the results obtained following conclusions can be made:

DREDGED MATERIAL:

1. The dredged material available at the bed of flood spill channel consists silty sand with appreciable fines.

2. The material is not suitable for use as a sub-base or base course due to low CBR value. However, it can be put to use as a sub-grade material for rural roads..

3. The material may also be used for manufacture of bricks and tiles, though more specific chemical and additional tests may be required. Also the introduction of additives may be required for such explicit application.

STABILIZED SOIL:

1. CBR value of stabilized samples increases with increase in cement content.

2. Unconfined compressive strength also increases with increase in cement content.

3. With addition of lime, CBR value increases but less as compared to cement.

4. Unconfined compressive strength increases with increase in lime content but less in comparison with cement.

5. The material is now suitable for use as sub-grade because of increase in CBR values.

Future scope of work:

The following work can be done in order to explore more about suitability of dredged material from Jhelum flood spill channel:

1. Conducting the laboratory direct shear test, permeability, consolidation and triaxial tests on the material.
2. Determining the various geotechnical parameters for the case of heavy compaction.

3. Organic content of the material may also b assessed.
4. Stabilization of dredged material can be carried out with more percentage of cement and lime to determine the optimum content of stabilizer to be used.
5. Determining the influence of water-cement ratio and curing period on the strength characteristics of the dredged material.

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INTRODUCTION

Boulevard road is one of the prestigious roads in the Srinagar city. The notability of the road lies in the fact that the entire road lies on the banks of Dal Lake. Major tourist spots like Chashmashahi, Parimahal, tulip garden, botanical garden etc are situated on the road. The economy of the people living here greatly depends on tourism. While driving across the road it provides glances of beauty of Dal Lake. In summers people rest on roadside and feel the cool breeze of Dal Lake and also enjoy the charming sunset from the horizon. Due to heavy rush of tourists, this road remains quite busy. In a bid to provide better road communication facilities to tourists, the Jammu and Kashmir government has initiated process of widening the famed Boulevard road along the Dal Lake. Since this road is the main attraction of Srinagar city there is heavy vehicular as well as pedestrian movement. Also this road attracts various cycling events, thus requires a track for cycles. The less width of carriageway of boulevard road usually irks the users. There are frequent traffic jams due to less width and heavy movement of vehicles and pedestrians. Hence, there should be sufficient carriageway width to avoid traffic menace and also sufficient space for on street parking of vehicles. There should also be separate track for cycles and sufficient footpaths for pedestrian traffic. Thus to allow the smooth flow of traffic and pedestrians this road needs upgradation.

In view of the proposed work, it is desired to redesign the pavement, including cycle track and conduct soil/material investigation and traffic survey. This had become necessary due to high level of water table, weak subsoil strata and due to requirement of detailed traffic survey. The Boulevard Road is a world famous road which has Dal lake on one side and Hills, especially Zabarwan Hill Range, on the other side. Post winter period the alignment gets inundated due to high level of water table and rain and snow-melt water from hill catchment. This makes it necessary to raise the level of the pavement proposed towards the hill side, conduct detailed soil/material investigation, carry out detailed traffic survey and design the pavement giving due considerations to drainage and such other site specific special conditions.

Also in view of this work, it is required to get the detailed classified traffic data on this road stretch & on the Habak - Dalgate (via Hazratbal) road to determine the likely shift of traffic from this road stretch after the upgradation is complete and analyze the same for working out parameters required for the structural design of the upgraded road pavement. To calculate the likely shift of traffic from Habak - Dalgate (via Hazratbal) road to Boulevard road, a Stated Preference (SP) survey has to be conducted also. Thus keeping above mentioned things in mind, we have come up with the idea of providing geometric and structural design for its upgradation. We will also try to solve the drainage problems encountered at this road during past. Samples of sub-grade soil were collected from the field at various RDs of the road, for the determination of their various characteristics. We conducted the geotechnical investigation and pavement analysis at the site and collected information and data on site-specific conditions. We conducted field soil sampling at the proposed site by excavating test pits at regular intervals along the existing road. It was required to test the sub-grade samples for Gradation, Consistency limits and indices, Compaction and CBR characteristics. Samples of Sub-base and base material were also tested for determining their required parameters.

Also, as a part of scope of this work, it was required to get the detailed classified traffic data on this road stretch & on the Habak - Dalgate (via Hazratbal) Road to determine the likely shift of traffic from this road stretch after the subject project is complete and analyze the same for working out parameters required for the structural design of the proposed road pavement. To calculate the likely shift of traffic from Habak - Dalgate (via Hazratbal) Road to Boulevard road, a Stated Preference (SP) survey was also conducted.

NEED OF STUDY

Boulevard road is one of the busiest road in the Srinagar city; there is heavy vehicular as well as pedestrian movement. Need of this study arises due to various reasons:

- Heavy vehicular traffic causing traffic congestion on this prestigious road,
- Various cycling events take place on this road, thus need for cycle tracks,
- Less width of carriageway of boulevard road usually irks the users. There are frequent traffic jams due to less width and heavy movement of vehicles and pedestrians,
- Pedestrian traffic is much more, thus need for sufficient footpaths for the same.
- Post winter period the alignment gets inundated due to high level of water table and rain and snow-melt water from hill catchment. This makes it necessary to raise the level of the pavement proposed towards the hill side, conduct detailed soil/material investigation, carry out detailed traffic survey and design the pavement giving due considerations to drainage and such other site-specific special conditions.

OBJECTIVES OF STUDY

Due to the factors mentioned in section 1.2, we are aiming at the following objectives:

- Structural upgradation of the existing road.
- Geometric upgradation of the existing boulevard road
- Suitable solution for the existing drainage problems at the proposed site, due to the high water table and other conditions
- Widening/4-laning of the existing road to overcome the menace of traffic congestion
- Provision of separate cycle tracks and footpaths for cyclists and pedestrian traffic.

BACKGROUNG

Highway engineering is an engineering discipline branching from civil engineering that involves the planning, design, construction, operation, and maintenance of roads, bridges, and tunnels to ensure safe and effective transportation of people and goods. Highway engineering became prominent towards the latter half of the 20th Century after World War II. Standards of highway engineering are continuously being improved. Highway engineers must take into account future traffic flows, design of highway intersections/interchanges, geometric alignment and design, highway pavement materials and design, structural design of pavement thickness, and pavement maintenance.

The beginning of road construction could be dated to the time of the Romans. With the advancement of technology from carriages pulled by two horses to vehicles with power equivalent to 100 horses, road development had to follow suit. The construction of modern highways did not begin until the late 19th to early 20th century. The first research dedicated to highway engineering was initiated in the United Kingdom with the introduction of the Transport Research Laboratory (TRL), in 1930. In the USA, highway engineering became an important discipline with the passing of the Federal-Aid Highway Act of 1944, which aimed to connect 90% of cities with a population of 50,000 or more. With constant stress from vehicles which grew larger as time passed, improvements to pavements were needed. With technology out of date, in 1958 the construction of the first motorway in Great Britain (the Preston bypass) played a major role in the development of new pavement technology.

Design policies standards used in the United States are typically based on publications of the American Association of State Highway and Transportation Officials as well as research promulgated by the Transportation Research Board, the Institute of Transportation Engineers, the Federal Highway Administration, and the Department of Transportation.