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STABILIZATION OF CLAYEY SOIL BY USING STONE SLURRY WASTE AND CEMENT: REVIEW

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ABSTRACT

The problem of disposal of the industrial waste resulted into the investigation of potential of industrial waste in stabilizing the clayey soils. The treatment of clayey soil by using the stone slurry waste and cement is very simple, pollution controlling and also solves disposal problem. The stone slurry waste taken from the stone cutting plant, stone slurry rich in calcium oxide. Cement induces bonding between the particles.

The study describes the effectiveness of stone slurry waste and cement to stabilize the clayey soils. The stone slurry waste and cement were mixed with clayey soils in different proportion and investigate the effect of stone slurry waste and cement on strength, compaction and CBR properties of clayey soil. The basic properties: direct shear, compaction and CBR were determined. The results shows that the addition of stone slurry waste and cement has significant effect on the clayey soil, which shows the effectiveness of this industrial waste in stabilizing the clayey soil

Keywords: Soil Stabilization, Stone Slurry, Cement, Clayey Soil, Strength, CBR.

I. INTRODUCTION

If weak soils exist, stabilization and improvement of their properties is necessary. The stabilization process aim to increasing the soil strength and reducing its permeability and compressibility. The stabilization process may include mechanical, chemical, electrical or thermal processes. The processes used depend on the type of soil at site, the time available to execute the project and the stabilization cost compared to the overall cost of the project. Expansive soil possesses great threat for the construction of buildings due to its less characteristic shear strength and high swelling and shrinkage characteristics. Problematic soils, especially expansive soil deposits are considered to be a potential natural hazard, which can cause extensive damage to structures if not adequately treated. During the last few decades, damage due to swelling action has been observed clearly in the semi-arid regions in the form of cracking and breakup of pavements, roadways, building foundations, slab-on-grade members, and channel and reservoir linings, irrigation systems, water lines, and sewer lines. In order to control this behavior, the expansive soils have to be suitably treated with industrial solid waste (stone slurry waste) or any other available materials which can alter its engineering behavior.

Hence appropriate measures are to be taken for the improvement of properties of soils, preferably before conducting construction work. A wide range of soil improvement methods has been used, including soil

replacement, dynamic compaction, lime/cement columns, stone columns, and soil reinforcements with fibrous materials. The selection of an appropriate method depends on ground characteristics, effectiveness, and practicality of the preferred technique and associated costs.

Soil stabilization is one of the oldest ground improvement techniques. Soil stabilization is the process of improving the engineering properties of soil and thus making it more stable. It is required, when the soil available for construction is not suitable for the intended purpose.

Soil stabilization is used to reduce the permeability and compressibility of the soil mass in earth structures and to increase its shear strength and bearing capacity of foundation soils. The main objective of soil stabilization is to increase the strength of soil and to reduce the construction cost by making best use of the locally available materials. There are many common methods-mechanical or chemical-found in the literatures that were used to improve the physical properties of the soils.The stabilization with cement and lime is well documented. Soil stabilization using cement is not generally preferable because of the increasing cost. Now we use stone slurry waste with cement to reduce the quantity of cement.

Over the last few years, utilization of by product of industrial solid waste has been focus of many researchers. Quarrying and stone cutting is the main extractive industry which produce huge amount of stone slurry waste during extraction, cutting and processing of rocks. The stone slurry waste is usually disposed indiscriminately in open areas and sewage network causing several health and environmental problems. The study aims to investigate using of the stone slurry waste and using specific amount of Portland cement to stabilizing the cohesive soil.

The stone slurry waste taken from stone cutting plant was dried, grinded to fine particle and then mixed with specific amount of Portland cement and cohesive soil.

Stone slurry wastes contain heavy metals and suspension solids and mainly consist of calcium carbonate ($CaCO_3$). The stone slurry waste is usually disposed indiscriminately in open areas and sewage network causing several health and environmental problems. The amount of waste accumulating from quarries, stone cutting plants and in open areas pressing problem facing the stone industry. In addition to depleting mineral resources, it causes serious environmental impact to water, air, soil, the landscape biodiversity and human communities. In general, the main issues associated with quarrying and stone production are:

1.) Slurry waste disposal reduces the area of fertile land.
2.) Increase in ph value and impact of flora, fauna and soil.
3.) High impact on air quality, ground water and surface water.
4.) Fine suspended solids cause respiration problems.
5.) Heavy metals in stone slurry are not soluble in water.
6.) Consumption of large amount of fresh water.

II. LITERATURE REVIEW

The beginning of modern soil stabilization started in the United States in 1920s, a time in which regulations were being imposed on many businesses during the expanding industrial era. Stone cutting industries that once disposed their by-products into their neighbourhood rivers, open areas and sewage network causing several

health and environmental problems. One solution was to promote the use of their waste as a dust palliative on dirt roads after dried. The development of better technology during the 1940s-1960s that the reason for this change had begun to be understood as being caused by a chemical reaction between the waste solution and the clay particles within the soil

Soil stabilization is the process of improving the engineering properties of the soil and thus making it more stable. It is required when soil available for construction is not suitable for the intended purpose. In the broad sense, stabilization includes compaction, pre-consolidation, drainage and many other such processes. Stabilization is the process of blending and mixing materials with a soil to improve certain properties of the soil. The process may include the blending of soils to achieve a desired gradation by the mixing of commercially available additives that may alter the gradation, texture or plasticity, or act as a binder for cementation of the soil. Soil stabilization is used to reduce the permeability and compressibility of the soil mass in earth structures, to reduce the swell in case of expansive soils and to increase its shear strength. Soil stabilization is required to increase the bearing capacity of foundation soils.

Expansive Soil is a term connected to any soil that has a potential for contracting or swelling under changing moisture conditions. Serious harm occurs to structures like light building, pavements, retaining walls, canal beds and linings etc. constructed on expansive soils. The mineral montmorillonite is for the mostly responsible for this kind of behaviour of soil. It expands in rainy season because of absorption of water and shrinks in summer. Expansive soils cover about 20% of the landmass in India and include nearly the whole Deccan level, Western Madhya Pradesh, parts of Gujarat, Andhra Pradesh, Uttar Pradesh, Karnataka, and Maharashtra.

Stone slurry waste is a one of the newest additives and many studies about using stone dust in soil improvement have been done. The use of stone slurry in some talented fields such as soil improvement, seepage and grouting will offer great advantages in geotechnics.

Stone slurry is the by-product material generated by cutting and shaping of building stones in cutting plants the water used for cooling up the cutting saw flows out carrying very fine suspended particles as high viscous liquid known as stone slurry. For stabilization we use stone slurry with cement because cement increases its cementaneous properties of soil.

Some of the investigative studies in which stone slurry has been used are described below:

III. REVIEW OF LITERATURE

Mousa f. atom & magdi el-emam, (2011) ,using cutting stone slurry waste as a stabilizing material with cohesive soil. Result indicate that mixing the cohesive soil with cutting stone slurry waste increased dry density and decreased optimum water content also increased direct shear and unconfined strength significantly due to addition of stone slurry to cohesive soil.

Al zboon & mahasneh, (2009), the use stone sludge as water source in concrete production has insignificant effect on compression strength, while it has a sharp effect on slump values.

Misra et al, (2008), the author using stone slurry powder in soil stabilization, production of bricks, tiles, mortars, and self compacting concrete.

Almedia et al, (2007), production of high performance concrete, the stone slurry powder used as a substitute of fine aggregate in concrete production.

Pappu et al, (2007), to effectively utilize these wastes as a raw material, filler, binder and additive in developing alternate building material, used in road construction, concrete, asphalt, aggregate cement.

Nabil al-joulani, (2007), the stone slurry powder was used in production of pvc pipes, tiles, blocks, pottery and other applications.

Binici et al. (2007), compressive strength and sulphate resistance of concrete increased with increasing percentage of marble dusts replacement with fine sand aggregates.

Silva et al. (2006), Resulted showed that granite and marble sludge can be added to the clay material with no detrimental effect on the properties of the sintered red clay products.

Katz and kovler (2004), production of controlled low strength materials by using significant amount of stone powder (25-50%),with some cementing or pozzolanic potentials as fly ash and cement kiln dust.

IV. MATERIAL USED

In this study, clayey subgrade soil is used with stone slurry waste to improve the CBR value of the clayey soil. Index properties of clayey subgrade soil are determined as per relevant Indian Standard and classification of soil is done on the basis of engineering properties of the soil.

V. CLAYEY SOIL

Clayey soil consists of microscopic and sub microscopic particles derived from the chemical decompositions of rocks. It contains a large quantity of clay minerals. It can be made plastic by adjusting the water content. It exhibits considerable strength when dry. Clay is a fine grained and cohesive soil. The particle size is less than 0.002 mm. Organic clay contains finely derived organic matter and is usually dark grey or black in colour. It has a conspicuous odour. Organic clay is highly compressible.

In clayey soils the absorbed water and particle attraction act such that it deforms plastically at varying water contents. This cohesive property is due to presence of clay mineral in soils. Therefore the term cohesive soil is used synonymously for clayey soils.

SAMPLE COLLECTION

Locally available clayey soil was collected from the fields of village Dayalpur District Kurukshetra.

The depth of 0.3 to 0.4 m below the ground surface by using technique of disturbed sampling and thoroughly hand sorted to eliminate the vegetative matters and pebbles

VI. STONE POWDER

It is the by product material generated by cutting and shaping of building stones in the stone cutting plants. The water used for cooling up the cutting saw flows out carrying very fine suspended particles as high viscous liquid known as stone slurry.

The chemical composition of stone slurry powder may vary depending on the origin of parent rocks. Basically, the stone slurry powder is composed of calcite, as denoted by high content of CaO and loss of ignition.

SAMPLE COLLECTION

Stone powder will be collected from the marble cutting site from Kurukshetra

VII. CEMENT

Cement is a very fine material used in many construction applications. Cement is obtained by pulverizing clinker formed by calcinating raw materials primarily consisting of lime(cao), silica(sio2), alumina (al2o3), and iron oxide (Fe2O3).there are many type of cement depending on its chemical composition and contents of calcium and magnesium. There are several studies which addressed the importance of using lime as a construction material and for soil stabilization in particular.

Cement improves the strength of fine soil by three mechanisms: hydration, flocculation and cementation. The first and second mechanisms occur almost immediately upon introducing cement. In our case we use Portland cement.

VIII. MIXING PROPORTIONS

Soil, stone slurry waste, cement is to be mixed thoroughly to have a uniform and homogenous mixture. Sample will be prepared using different combination of stone slurry waste, cement and parent soil and different tests will be conducted on the prepared samples and result will be compared with the original clay sample.

Sample 1:

Clayey soil =100%

Sample 2:

Clayey soil = 75%

Stone slurry waste = 20%

Cement = 5%

Sample 3:

Clayey soil = 70%

Stone slurry waste = 23%

Cement =7%

Sample 4:

Clayey soil = 60%

Stone slurry waste = 30%

Cement =10%

IX. TESTING PROGRAMME

For obtaining the significant result we will conduct tests on specimens. These tests result gives compressive strength, indirect tensile strength and natural absorption. These tests are:

A. Direct shear test: This test conducted on different percentage of additives. This percentage decided. By using this test we can find shear strength parameters (C, φ) of soil with different percentage of additives.

B. Compaction test: The objective of this test is to determine the maximum dry density and optimum moisture content at different percentage of additives and to use these results in the preparation of CBR specimens. The standard proctor test results give the variation of dry density values with moisture contents for soil samples with different percentage of additives.

C. CBR Test: the CBR test vales are commonly used in mechanistic design and as an indicator of strength and bearing capacity of sub grade soil, sub base and base course material for use in road and airfield pavement.

- Apart from these tests liquid limits test, plastic limit test, shrinkage limit test, grain size analysis and specific gravity test will be conducted on the parent clay and stabilizer as well as on the prepared samples.

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