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Stabilization of black cotton soil using the waste fishing net

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ABSTRACT

There is Black cotton soil in most parts of central and western parts of India and covering approximately 20% of the total area of India and it has been a challenge to highway engineers since this soil is highly susceptible to moisture changes. Soil stabilization is a technique to improve the engineering characteristics of the soil. Certain soils possess undesired properties making their use in the constructions very difficult. These include high permeability, high compressibility, and reduced shear strength. Modification of soil by chemical admixtures is a common stabilization method for such soils. The main objectives of the proposed project is to determine the index and engineering properties of Black cotton soil, determination of engineering properties of fish net fibre modified soil, reducing swelling tendency of moist compacted Black cotton soils, to check the efficacy of fish net fiber (Grid type) reinforced soil as a fill material through laboratory model studies. Soil stabilization using fishing net can help to enhance soil strength, stabilize near-surface soil layers and mitigate the risk of soil liquefaction. For roads with heavy traffic and locations of extreme climatic conditions, soil stabilization is generally recommended and the method can be adopted after a proper study. This investigation aims at checking the feasibility of using waste fishing net fibers and improving the strength and compaction characteristics of the soil. Waste fishing net fibers are added in a layer-wise and an optimum configuration has arrived.

Keywords: *Black cotton soil, Optimum moisture content, Maimum dry density, and Fish net.*

1. INTRODUCTION

Black cotton soil deposits occur in the arid and semi-arid regions of the world and are problematic to engineering structures because of their tendency to heave during the wet season and shrink during the dry season. Black cotton soils are made of varying properties of mineral like montmorinolite and kaolinite, chemicals like iron oxide and calcium carbonate and organic matters like humus. Montmorinolite is a predominant mineral of black cotton soil. The swelling and shrinkage behavior of black cotton soil originate mainly from this mineral. Black cotton soils are worldwide problems that possess several challenges for civil engineers. They are considered as a potential natural hazard, which can cause extensive damage to structures if not adequately treated. Black cotton soils will cause more damage to structures, particularly light buildings and pavements, than any other natural hazard, including earthquakes and floods. Black cotton soils are semitropical soils found in areas. They range from black to dark gray. They tend to become hard with very large cracks when dry and very soft and spongy when wet. For every construction on land, we require a strong foundation. The strength and durability of a structure depend largely on the strength of its foundation. For a foundation to be strong, the soil in and around it should be strong. Soil generally has low tensile and shear strength and these characteristics change with changing environmental conditions. But, with the incorporation of certain materials, these properties could be improved. Soil stabilization is that technique which improves the strength of the soil to meet the required engineering properties. The Chinese and Romans have adopted soil stabilization techniques since time immemorial. In India, soil stabilization started attaining momentum since the 1970s.

Introduction of fibers ranging from polypropylene, steel bars, polyester, glass fibers and biodegradable fibers into soil has been proven effective in soil stabilization. Some recent initiatives such as fishing net and waste plastic materials as reinforcements have also been proved successful. These added fibers have high tensile strength and extendibility, which helps reduce compressibility and brittleness of the host soil. This method is far superior to conventional methods such as stabilization using cement, lime, etc. These stabilizing fibers can be placed in a layer-wise.

1.1 Objectives of the study

The main objectives of the study are to determine the effect of cost-effective additives such as waste fishing net on the engineering and index properties of weak soils, to arrive at an optimum layer of addition resulting in maximum improvement in engineering properties of soil and also to compare the strength and deformation characteristics of stabilized soil with that of black cotton soil

1.2 Scope of the study

The black cotton soil is used as construction material whose bearing capacity is extremely low. These clayey soils undergo volumetric changes with a change in moisture content, swelling and shrinkage of these soil cause severe damage to the foundations, buildings, roads, retaining structures etc. Therefore, a thought on how to enhance the strength properties of the clayey soil by adding fish net. The addition of fish net results in increased strength and reduced permeability. So the stabilized soil can be used for construction purpose as well as pavement work. Here, we are using the waste fishing net as a stabilizing agent which will reduce the effect of pollution on the environment to a great extent.

1.3 Methodology

The index and engineering properties of the obtained soil sample was determined as per IS specifications. Major tests include Atterberg limits, heavy compaction test, and CBR test. Compaction Tests were conducted on black cotton soil and find out optimum moisture content (OMC) of the soil. The improvement in soil properties namely compaction and strength parameters are measured by the addition of fishing net, which is added in a layer-wise. CBR test was conducted to study the effect of waste fishing net fibers on the soil.

2. EXPERIMENTAL STUDY

2.1 Black cotton soil

The soil is classified and identified based on the index properties. Water content, specific gravity, and particle size distribution are the index properties of clayey soil. The properties were generally determined in the laboratory shown in Table 1.

2.2 Fish Net Fiber

Fish net used in this study was collected from Beypor harbor. The collected fish net is made of nylon fiber. The properties of fish net were shown in Table 2. The general properties were provided by the manufacturer.

Table-1: Properties of soil

Soil property	**values**
Natural water content (%)	42.26
Specific gravity	2.589
Percentage of gravel (%)	0
Percentage of sand (%)	16.6
Percentage of silt (%)	15
Percentage of clay (%)	68.4
Liquid limit (%)	72
Plastic limit (%)	34.01
Plasticity index (%)	37.99
IS classification	CH
CBR (%)	1.42
Free swell index (%)	80

Table-2: Properties of fish net fiber

Properties	Value
Colour	Red
Mesh aperture size (cm)	0.5 x 0.5
Thickness of fiber	0.8mm
Density of fiber	1.5 to 2 g/cm^3

3. RESULTS AND DISCUSSION

3.1 Determination of Maximum Dry Density and Optimum Moisture Content of Black cotton soil treated with Fish Net Fibers

Maximum dry density and optimum moisture content of Black cotton soil alone are 1.55 (g/cc) and 19 % respectively. The results of compaction test on Black cotton soil treated with different layers of Fish Net Fibers are given in Figure1

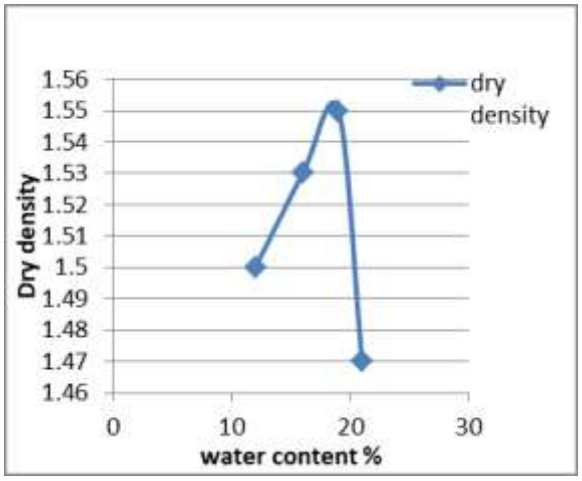

Figure-1: Compaction test of black cotton soil alone

3.2 Determination of California Bearing Ratio value of Black cotton soil treated with Different Layers of Fish Net Fibers

The purpose of the California bearing ratio test is to determine the Capacity of the Black cotton soil (CBR %) for a particular Black cotton soil and Fish Net Fiber. The CBR test performed with different layers of fish net proved that the CBR value increased up to 2 layers but decreased when the number of layers increased to 3. Thus we can conclude that addition of two layers of fishing net is optimum. From various laboratory test conducted it was obtained that the CBR value for black cotton soil alone and soil with an optimum layer of fish net are 1.42 and 4.825 respectively. By comparing the CBR Values of soil alone and soil with two layers of fish net fiber, we concluded that the bearing capacity of the soil is increased in the soil with the optimum layer.

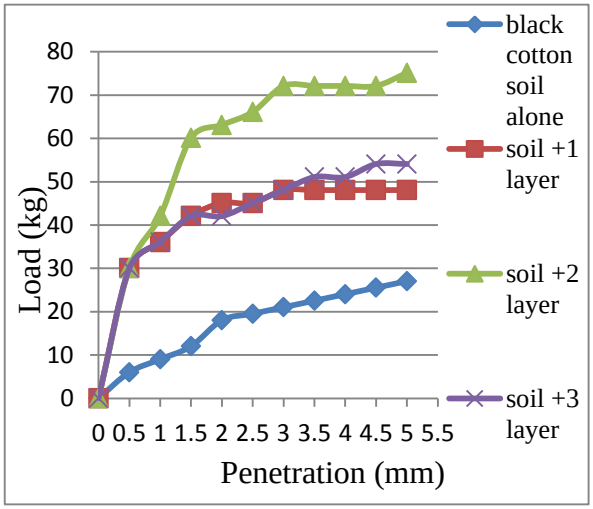

Figure-2: CBR Curves for Black cotton soil and Black cotton soil mixed with different Layers of Fish Net Fibers

3. CONCLUSIONS

In this study, the waste fishing net was utilized for stabilizing the black cotton soils. The soil sample was collected from Pollachi and identification test were carried and confirmed as the black cotton soil of high plasticity. Since CH soil is weak, we should provide suitable treatment options such as the use of fibers or other stabilization methods. Stabilization becomes more effective when using waste products and it should economically benefit. Thus, here we introduce waste fishing net as a stabilizing agent. Laboratory tests were conducted to find the effects of fish net on black cotton soil and free swell index of soil is found to be 80%. The value is greater than 50 %, i.e. the soil shows a very high degree of expansiveness. It is a property of the black cotton soil, and also from various test results, it was concluded that the collected soil is black cotton soil.

The optimum moisture content and maximum dry density were found out as 19% and 1.55 respectively. The CBR value for black cotton soil alone and soil with an optimum layer of fish net are 1.42 and 4.825 respectively. By comparing the CBR Values of soil alone and soil with two layers of fish net fiber, we concluded that the bearing capacity of the soil is increased in the soil with the optimum layer.

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