Soil Stabilization by Using Agricultural Plastic Waste

Mohite B M[1], Sharma S R[2], Desai A A[2], Patil R S[2], Patil S R[2], Kadam S V[2]

[1]Professor, Department of Civil Engineering, Jaywant College of engineering and polytechnic, K.M. Gad, India.

[2]Student, Department of Civil Engineering, Jaywant College of engineering and polytechnic, K.M. Gad, India.

Corresponding Author: Shubhamsharma4019@gmail.com

Abstract: - Soil stabilization is a process which improves the physical properties of soil, such as increasing shear strength, bearing capacity etc. which can be done by use of controlled compaction or addition of suitable admixtures like cement, lime and waste materials like fly ash, phosphor gypsum etc. This new technique of soil stabilization can be effectively used to meet the challenges of society, to reduce the quantities of waste, producing useful material from non-useful waste materials.

Plastic such as Pepci drip lateral is used to as a reinforcement to perform the CBR studies while mixing with soil for improving engineering performance of sub grade soil. Crushed plastic obtained from waste plastic were mixed randomly with the soil. A series of California Bearing Ratio (CBR) tests were carried out on randomly reinforced soil by varying percentage of crushed plastic with different proportions. Results of CBR tests demonstrated that inclusion of waste crushed plastic in soil with appropriate amounts improved strength and deformation behavior of sub grade soils substantially.

Key Words: Soil stabilization, California Bearing ratio, Black cotton soil, Pepci drip lateral.

I. Introduction

Plastics are inexpensive, lightweight and durable materials, which can readily be moulded into a variety of products that find use in a wide range of applications. On an average, an Indian uses 1 Kg of plastics per year and the world annual average is an alarming 18 kg. As per data available on Municipal Solid Waste (MSW) 2009, approximately,4000-5000 ton per day plastic wastes are generated. As a consequence, the production of plastics has increased markedly over the last 60 years. Today, every vital sector of the economy has been virtually revolutionized by the application of plastic. According to recent studies, plastic can stay unchanged for as long as 4500 years on earth. Use of this non-biodegradable product is growing rapidly and the problem is what to do the plastic waste. Several million metric tons plastic wastes are produced every year. Natural materials being exhaustible in nature, its quantity is declining gradually. Also, cost of extracting good quality of natural material is increasing.

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Concerned about this, the scientists are looking for alternative materials for soil stabilization, and plastic wastes product is one such category. To deal with the growing disposal problem of these materials is an issue that requires co-ordination and commitment on the part of all parties involved such as government agencies, companies, the public and professionals. One method to reduce some portion of the plastic waste disposal problem is by recycling and utilizing these materials in the stabilization of expansive soil.

Therefore, for sustainable development use of locally available plastic waste materials should be encouraged. The objective of this study was to make economical and to maintain environmental balance, and avoid problems of waste plastic disposal i.e. the use of plastic waste for stabilization of black cotton soil and its possible combined utilization with various proportions to obtain maximum stability.

Stabilization of soils is an effective method for improving the properties of soil and pavement system performance. The objectives of any stabilization technique used are to increase the strength and stiffness of soil, improve workability and constructability of the soil and reduce the Plasticity Index. For any given soil many stabilization methods, using different stabilizing agents, may be effective to improve the soil properties in-place rather than removing and replacing the material. Availability or financial considerations may also be the determining factor on which a stabilizing agent is selected.

II. PERSONALITY ASSESSMENT THEORY

Industrial development in India has necessitated construction of infrastructure facility such as highways, airports seaports and residential, commercial buildings. There is a need to select a good soil condition for proper safety consideration of all these projects. Such soils exhibit extreme stages of consistency from very hard to very soft when saturated. Expansive soils contain minerals that are capable of absorbing water. They undergo severe volume changes corresponding to changes in moisture content. They swell or increase in their volume when they imbibe water and shrink or reduce in their volume on evaporation of water (Chen 1998). Because of their alternate swelling and shrinkage, they result in detrimental cracking of lightly loaded civil engineering structures such as foundations, retaining walls, pavements, airports, side -walks, canal beds and linings (Chen 1988).

Due to these reasons expansive soils are generally poor material for construction. So, to improve the engineering properties of soil, stabilization or reinforcement is done. Soil stabilization is the process of blending and mixing materials to improve engineering properties of soil like increasing shear strength, compressibility and permeability, thus improving load bearing capacity of a sub-grade to support pavements and foundations. For many years, engineers have used traditional additives such as lime, cement and cement kiln dust etc. to improve the qualities of readily available local soils. The stabilization of expansive soils with cement and lime is well documented. Cement stabilization nowadays is less appreciated because of the increasing cost of cement and environmental concerns related to its production. India being the second largest producer of cement has a very heavy impact on CO2 emission. One can imagine from the fact that approximately one tone of CO2 is produced during the production of one tone of cement. On the other hand, lime also contributes CO2 to the world climate during its production. The cost of these additives has also increased in recent years. This has opened the door widely for the development and introduction of other soil types of additives, such as plastic, bamboo, stabilization liquid enzyme soil etc. open.

2.1 Soil Stabilization

Soil stabilization a general term for any physical, chemical, mechanical, biological or combined method of changing a natural soil to meet an engineering purpose.[1] Improvements include increasing the weight bearing capabilities, tensile strength, and overall performance of in-situ subsoils, sands, and waste materials in order to strengthen road pavements.

Some of the renewable technologies are: enzymes, surfactants, biopolymers, synthetic polymers, co-polymer-based products, cross-linking styrene acrylic polymers, tree resins, ionic stabilizers, fiber reinforcement, calcium chloride, calcite, sodium chloride, magnesium chloride and more. Some of these new stabilizing techniques create hydrophobic surfaces and mass that prevent road failure from water penetration or heavy frosts by inhibiting the ingress of water into the treated layer.

2.2 What is Soil Stabilization

Soil Stabilization is the alteration of soils to enhance their physical properties. Stabilization can increase the shear strength of a soil and/or control the shrink-swell properties of a soil, thus improving the load bearing capacity of a sub-grade to support pavements and foundations.

Soil Stabilization can be utilized on roadways, parking areas, site development projects, airports and many other situations where sub-soils are not suitable for construction. Stabilization can be used to treat a wide range of sub-grade materials, varying from expansive clays to granular materials. This process is accomplished using a wide variety of additives, including lime, fly-ash, and Portland cement. Other material byproducts used in Stabilization include lime-kiln dust (LKD) and cement-kiln dust (CKD).

2.3 Black cotton soil

Expansive soils, popularly known as black cotton soils in India are, amongst the most problematic soils from Civil Engineering construction point of view. Of the various factors that affect the swelling behavior of these soils, the basic mineralogical composition is very important. Most expansive soils are rich in mineral montmorillonite and a few in illite.

The degree of expansion being more in the case of the former. Soil suction is another quality that can be used to characterize a soil’s affinity for water on its volume change behavior.

Black cotton soil is heavy clay soil, varying from clay to loam; it is generally light to dark grey in colour. Cotton grows in this kind of soil. The soil prevails generally in central and southern parts of India.

The most important characteristic of the soil is, when dry, it shrinks and is hard like stone and has very high bearing capacity. Large cracks are formed in the bulk of the soil. The whole area splits up and cracks up to 150 mm wide are formed up to a depth of 3.0 to 3.5 metre. But when the soil is moist it expands, becomes very soft and loses bearing capacity.

Due to its expansive character, it increases in volume to the extent of 20% to 30% of original volume and exerts pressure.

The upward pressure exerted becomes so high that it tends to lift the foundation upwards. This reverse pressure in the foundation causes cracks in the wall above. The cracks are narrow at the bottom and are wider as they go up.

The unusual characteristics of the soil make it difficult to construct foundation in such soil. Special method of construction of foundation is needed in such soil.

III. MATHEMATICAL MODEL

Let Room temperature: 25°C

Table.1. Observation of Liquid limit

No. of blows	28	21	38	3
Can. No.	A	P	C	3
Mass of con. (gm)	14	14	28	34
Mass of con. + Wet soil (gm)	34	28	44	38
Mass of con. + Dry soil (gm)	26	22	38	48
Mass of water	8	6	6	10
Mass of dry soil	12	8	10	14
Water content (%)	66.66	75	60	71.
Average	68.37%			

CALCULATION

Percentage of moisture content

= (weight of moisture x 100%) / (weight of dry soil)
= 8 x 100 / 66.66%

IV. RESULTS AND DISCUSSION

California Bearing Ratio at 2.5mm penetration = 2.84

California Bearing Ratio at 5.0mm penetration = 3.37

California Bearing Ratio of subgrade soil = 3.37

V. CONCLUSION

The plastic inclusions can improve the strength thus increasing the soil bearing capacity of the soil.

Use of plastic waste as reinforcement is recommended to reduce the quantities of plastic waste, which creates the disposal problem. Successful application of plastic waste could help to reduce the amount of plastic waste which is disposed of to landfills and contribute to sustainable development by providing low-cost material to the resource intensive geotechnical industry Results by CBR test concludes that the bearing capacity of the soil is increased at 1% of adding plastic waste (Pepci drip lateral).

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