An Experimental Study on Soil Properties by Inducing Plastic Strips

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Abstract: Black Cotton soils with high potential for swelling and shrinking as a result of change in moisture content are one of the major soil deposits. Soil stabilization is the process which improves the physical properties of soil, such as shear strength, bearing capacity which can be done by use of controlled compaction or addition of suitable admixtures like cement, lime, sand, fly ash or by providing geo textiles, geo synthetics etc. The 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 Since the use of plastic in diversified forms such as chairs, bottles, polythene bags, etc., has been advancing speedily and its disposal has been a problem all the time regarding the environmental concern, using plastic as soil stabilizer would reduce the problem of disposing the plastic as well as increases the density and California Bearing Ratio (CBR) of soil in an economical way. In the present study, an experimental program was conducted for stabilization of Black Cotton Soils by adding plastic strip An experimental program was undertaken to study the effect on High Compressibility clays reinforced with randomly distributed plastic fibers of different aspect ratio were mixed with expansive soil in different proportions. Samples were tested with 0%, 2% ,4%, 6%, 8% of 12mm plastic fibers by dry weight. The results of Compaction were described. The influence of test parameters such as the amount of reinforcement and moisture content are discussed. Based on the results obtained, it was observed that there is significant decrease in MDD values with the inclusion of Natural fibers up to 8 % fiber content for 12mm fiber length and OMC is almost constant up to 4% and after that it will slightly increase.

KEYWORDS: Expensive soil, plastic fibres, CBR test.

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INTRODUCTION

Now a days, Plastic industry is booming with more developments in technology fields. The plastic products are produced in automobile, electronic and electrical materials etc. The use of plastic bags is also on a boom. The recycling of plastic is expensive. The burning of plastics produces harmful gases liked ioxins, mercury, Polychlorinated biphenyls (BC Ps) also produces gases which trap heat leading to global warming. The decomposition of plastic is also not possible. Landfill methods of plastic disposal affect the atmosphere. The leaching of plastic due to acidic environment of soil affects the organisms. So, there is a need to develop new methods to dispose the plastic materials. For disposing of plastic waste, we can use plastic waste for stabilization of soil. Soil stabilization is any process which improves the engineering properties of soil, such as increasing shear strength, bearing capacity etc. Soil stabilization techniques can broadly be classified into three types namely: -

Mechanical: The oldest types of soil stabilization are mechanical in nature. It involves physically changing the property of the soil. Dynamic compaction is one of the major types of soil stabilization, in this procedure a heavy weight is dropped repeatedly onto the ground at regular intervals to quite literally pound out deformities and ensure a uniformly packed surface. Vibro compaction is another technique that works on similar principles, though it relies on vibration rather than deformation through kinetic force to achieve its goals.

Chemical: chemical techniques believe on adding an additional material to the soil that will physically interact with it and change its properties. There are a number of different types of soil stabilization that believe on chemical additives of one kind or another, frequently encountered compounds are utilization of cement, lime, fly ash, or kiln dust. Most of the reactions sought are either cementitious or pozzolanic in nature, depending on the nature of the soil.

Polymer/Alternative: Most of the newer discoveries and techniques developed thus far are polymer based in nature such as processed polymer fiber or wastage materials such as polythene bags, plastic bottles, recycled plastic pins. These new polymers and substances have a number of significant Soil Stabilization using Plastic; they are cheaper and more effective in general than mechanical solutions, and significantly less dangerous for the environment than many chemical solutions. In this project stabilization is achieved by polymer method, by using plastic covers. The plastic covers were chosen as material for stabilization, as it contributes to 35% chunk of the total plastic wastage. Thus, utilizing it in soil stabilization helps to converse the natural resources and reduce the waste heap. Also, plastic strip is inert and degradable so it effectively remains in soil for many years. The objective of this study was improving properties of soil in economical way and reducing environmental pollution, and minimize the problems of plastic waste disposal.

1.1 PRINCIPLES OF SOIL STABILIZATION

- ➢ Evaluating the properties of given soil
- ➢ Deciding the lacking property of soil and choose effective and economical method of soil stabilization.
- ➢ Designing the Stabilized soil mix for intended stability and durability values.

1.2 OBJECTIVES

- ➢ To increase the density and California Bearing Ratio (CBR) of soil using plastic as an admixture.
- ➢ To provide an alternative solution for the disposal of plastic fibres.
- ➢ To provide an economical solution for soil stabilization using plastic fibres.
- ➢ To determine the optimum plastic content to be used.

1.3 SCOPE

Through this project, a small attempt has been made at deducing a new method of waste disposal in effective manner. This project aims at proposing a new method of disposal of waste plastic (PET)by using them in stabilization admixture.

RELATED WORK

Tarun Kumar, Suryaketan May 2018

This study is carried out on the development of the roadways which is very important and required to be strong enough to support different loads. To meet these challenges plastic wastes are used in the forms of strips of various sizes for identifying the required percentage amount of plastic strips and providing the alternative way for disposing the plastic wastes. To study this

reinforcing effect of mixed plastic strips in soil, a series of standard proctor and unsoaked CBR tests have been conducted and based on this it is observed that the maximum dry density of plastic mix soil decreases with increase of percentage of plastic strips, and for CBR increases with increase of percentage of plastic strips within a certain limit. Based on this conclusion should be drawn is that by increasing the amount of plastic contents, the value of the MDD decreases whereas the value of OMC increases. There is increase in CBR value for soil with increasing the percentage of plastic strips. The maximum CBR value is obtained when the percentage of the plastic strips is 0.8% of dry weight of soil. Hence 0.8% of strips having length of 2cm is considered as required amount.

Proff.Harish C, Ashwini HM (2018) also researched on soil stabilization using plastic waste. The waste plastic material i.e. plastic bottles are used in this project. The waste plastic bottles are taken and cut into small strips. The addition of these small strips in the soil by different percentage and conduct tests such as liquid limit, plastic limit, compaction test, CBR test etc. Then soil becomes stabilized i.e. increasing the load bearing capacity of the soil and also strength properties such as shear strength with a controlled compaction. Soil stabilization by using waste plastic bottles which significantly enhance the strength properties of the soil.

K.Geetha Manjari et.al. (2011)presented paper on Compressibility and permeability behavior of plastic waste mixed Sand'. According to their investigation, they provided experimental results on the one-dimensional compression test and permeability for plastic waste mixed sand. Based on experimental test results, it was observed that the compressibility and permeability reduced significantly with addition of a small percentage of plastic waste to the soil. In his analysis, to investigate the effects of plastic waste on the engineering properties of soils, a series of tests were performed on sand. One-dimensional consolidation test was performed for different percentages of plastic waste mixed sand.

A. K. Choudhary, J.N. Jha and K.S. Gill, (2010) IN the present time the performance of paved and unpaved roads is often poor after every monsoon. Attempts have been made in this study to demonstrate the potential of reclaimed HDPE as soil reinforcement for improving engineering properties of the subgrade soil. Strips obtained from waste plastic with various dimensions were mix randomly with soil and find out appropriate amount of HDPE strips. They performed tests and interpreted the data based on the ratio of length to width of the strip. He also mentioned that as most of the plastic bags are made of high-density polyethylene material, hence there is a rapid increase in the amount of the plastic material in the environment.

MATERIALS AND MOTHODOLOGY

In this chapter, the various materials used in this experiment are:

3.1 Materials:

3.1.1 Fiber:

Plastic Fiber is a strip r-like strand of material. It is flexible and can be spun or twisted for weaving, braiding, knotting, crocheting, etc. to make desired products. Fibers can be obtained in artificial from as well as in synthetic form. Man-made or synthetic fibers are either made up of chemicals or by recycling to create new fiber structures/properties.

3.1.2 Expensive soil:

In India the expansive soil is called the black cotton soil which covers 3, 00,000 sq. widely.

The term expansive soil applies to soils that have the tendency to swell when their moisture content is increased. Soils containing the clay mineral montmorillonite generally exhibit these properties (Chen 1975). Black cotton soils of India are well known for their expansive nature. These expansive soils are called black cotton soils because of their predominant black color and the cotton crop that is grown abundantly on such soils. These soils cover about 106 km^2areas which cover more than one-fifth of the country and extend over the states of Maharashtra, Gujarat, Southern part of Utter Pradesh, eastern part of Rajasthan, southern and western part of Madhya Pradesh, and few parts of Andhra Pradesh and Chennai. Expansive soils having inherent property of shrinking when it is dried and swelling when water is absorbed. When water is absorbed the clayey soil which had shrink by the evaporation of pore water, the compression forces between soil particles reduces

considerably and elastic expansion occurs and this causes swelling.

Fig. shows plastic used for randomly mixed with black cotton soil

The plastic used for randomly distribution is obtained from the plastic waste products such as plastic water bottles and broke n chairs polythene bags etc., are crushed in to the required size ie.10-12 mm by the plastic crushing equipment.

Fig shows Plastic wastage materials

3.2 Methodology:

Soil Properties

The soil is obtained from Polavaram, West Godavari district. Different properties tested in laboratory are

- Index Properties
- Engineering Properties

3.2.1 Index properties:

• Soil index properties are the properties of soil that indicate the type and conditions of the soil and provide a relationship to structural properties and are used extensively by engineers to discriminate between the different kinds of soil within a broad category, e.g. clay will exhibit a wide range of engineering properties depending upon its composition. Classification tests to determine index properties will provide engineers with valuable information when the results are

• Compared against empirical data relative to the index properties determined. The below are the different index properties of the soil.

Liquid limit

The minimum water content at which the soil retains its liquid state and possesses a small shearing resistance against flowing, is known as liquid limit.

Plastic Limit

Plastic limit is the water content below which the soil stops behaving as a plastic material, loses its plasticity and passes to a semisolid state, it begins to crumble when rolled into threads of 3 mm diameter.

The experiment is performed according to IS2720. The Water Content at which the soil begins to crumble at 3mm diameter is called as plastic limit.

Free swell index

- Two samples of dried soil weighing 10gm each and passing through 425µ sieve are taken.
- One sample of 10gm is taken into a 50cc graduated glass cylinder containing kerosene oil (a non polar liquid).
- The other sample is taken into similar cylinder containing distilled water.
- Both the samples are left undisturbed for 24hrs then there volumes are noted.
- The degree of expansiveness and possible damage to lightly load structures maybe
- Qualitatively assessed from the following table.

v_w = volume of soil in water after 24 hours

v_k =volume of soil in kerosene after 24 hours

Degree of expansiveness

Free swell index	Degree of expansiveness
<20	Low
20 – 35	Moderate
35 – 50	High
>50	Very high

Wet Sieve Analysis

Wet Sieve Analysis is done if the soil contains a substantial quantity more than 50% of fines, this is conducted according to IS: 2720.

1. All lumps in the soil are broken into individual particles.
2. About 500g soil sample is taken, using a rimer, and dried in an oven.
3. The dried sample is taken in a tray and saturated with water. (If deflocculating is required, sodiumhexameta-phosphate, at the rate of 2 g per liter of water, is added).
4- The sample is stirred and left for a soaking period of at least one hour.
5. The slurry is then sieved through a 4.75 mm sieve, and washed with a jet of water.
6. The material retained on the sieve is the gravel fraction. It is dried in an oven, and sieved through set of coarse sieves.
7. The material passing through 4.75 mm sieve is sieved through a 75micron sieve. The material is washed until the wash water becomes clear.
8. The material retained on the 75micron sieve is collected and dried in an oven.
9. It is then sieved through the set of fine sieves of the size 2 mm, 1 mm, 600micron, 425micron, 150micron, and 75microns.
10. The material retained on each sieve is collected and weighed. The material that would have been retained on pan is equal to the total mass of soil minus the sum of the mass of material retained on all sieves.

3.2.2 Engineering properties:

1. Compaction Test:

Compaction is the process of densification of soil mass by reducing air voids. The purpose of laboratory compaction test is so determine the proper amount of water at which the weight of the soil grains in a unit volume of the compacted is maximum, the amount of water is thus called the Optimum Moisture Content (OMC). In the laboratory different values of moisture contents and the resulting dry densities, obtained after compaction are plotted both to arithmetic scale, the former as abscissa and the latter as ordinate. The points thus obtained are joined together as a curve. The maximum dry density and the corresponding OMC are read from the curve.

2. California bearing ratio test (CBR) test:

The California bearing ratio test is penetration test meant for the evaluation of sub grade strength of roads and pavements. The results obtained by these tests are used with the empirical curves to determine the thickness of pavement and its component layers.

II. RESULTS AND DISCUSSION

4.1 Soil Properties:

Area	Polavaram
Depth	3.0m
Grain Size Analysis	
Gravel	3.5%
Sand	6.5%
Fines(silt+clay)	90%
Index Properties	
Liquid limit	53%
Plastic limit	25.1%
Plasticity Index	25.44
Specific Gravity	2.52
Free Swell Index	70
Soil Classification	CH
Engineering Properties	
Optimum Moisture Content(OMC)	16%
Maximum Dry Density(MDD)	1.417g/cc
CBR (%)	5.3%

Table shows soil properties

4.2 Fiber Properties:

The materials used for the present study are plastic Fiber, The material properties are given in Table 4.2

Table shows Fiber Properties

Fiber Type	Natural
Fiber Cut Length	12mm
Color	Yellow, Red, blue and transparent fibers
Thickness	0.5 mm
Specific gravity	1.36

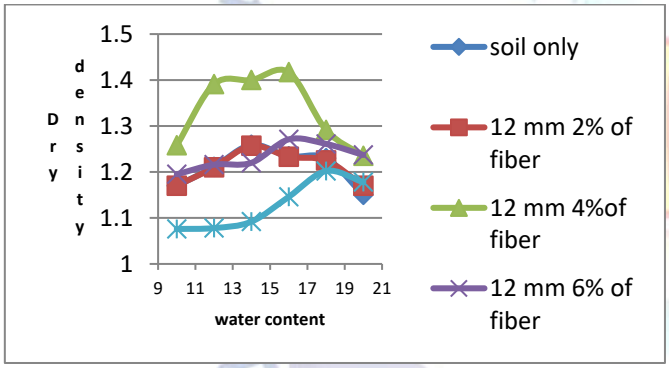
A. COMPACTION TEST:

Variation of compaction characteristics with varying percentage of fibers

Moisture content	Soil only	Soil&12mm fibers			
	Dry Density				
	0%	2%	4%	6%	8%
10	1.17	1.17	1.25	1.19	1.076
12	1.22	1.21	1.39	1.21	1.078
14	**1.27**	**1.25**	1.38	1.22	1.092
16	1.24	1.23	**1.41**	**1.27**	1.146
18	1.23	1.22	1.29	1.26	**1.202**

Compaction Characteristics:

Chart 4.1 Variation of OMC with Percentage of fibers.



B. CBR TEST:

Only soil

S No	Penetration in mm	Proving ring reading	Correction load in kg
1	0.5	1	8.68
2	1	2	17.36
3	1.5	3	26.04
4	2	4	35.72
5	**2.5**	**5**	**43.4**
6	3	6	52.08
7	4	8	63.51
8	**5**	**9**	**73.98**
9	7.5	12	100.02
10	10	14	117.38
11	12.5	16	134.74

Table shows Penetration test values for soil (1 division=8.68kg)

Penetration (mm)	Standard Load (kg)	Unit Standard Load (kg/cm^2)
2.5	1370	70
5.0	2055	105
7.5	2630	134
10.0	3180	162
12.5	3600	183

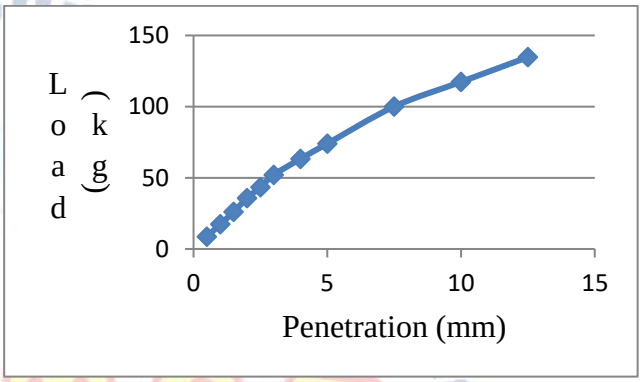


Chart 4.2: penetration test curve for soil

We will take the greater CBR value among the 2.5mm and 5mm penetration.

CBR Value for soil = 3.5%

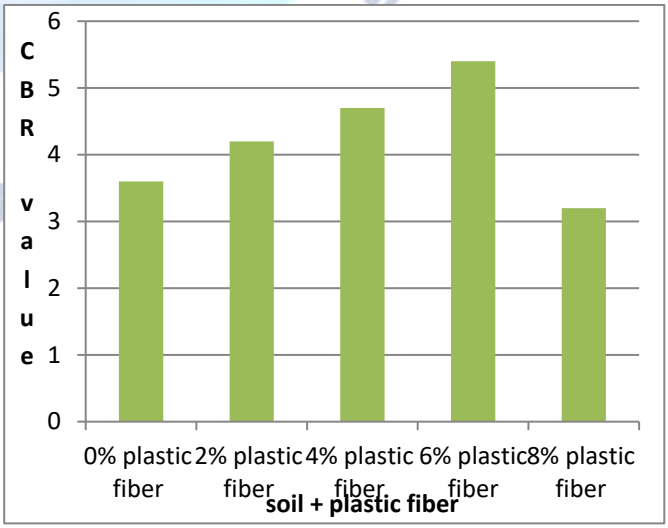
CBR Value for soil + 2 % plastic fibers =4.10%

CBR Value for soil + 4 % plastic fibers = 4.5%

CBR Value for soil + 6 % plastic fibers = 5.3%

CBR Value for soil +8 % plastic fibers = 3.1%

Chart 4.3: CBR values for unsoaked condition



CONCLUSION

Based on the results presented in this study, the following conclusions are drawn

- Addition of fibers to Black Cotton soil increase the MDD up to 6% fiber by dry weight after that the MDD value is decrease for 12mm length fiber.
- Addition of fiber to Black Cotton soil increases OMC values up to 6% fiber by dry weight and attain maximum value at 8% 0f plastic fibers to the soil 12mm fibers.
- The values of CBR is increase up the 6% of addition of fibers to the soil after that the CBR value is decreased.

FUTURE SCOPE

- Perform laboratory investigations to determine the CBR (California Bearing Ratio) values for both saturated condition and OMC and MDD conditions.
- Mixing the soil with natural fibers for same aspect ratios or for different aspect ratios.
- Mixing the soil sample to the artificial fibers with greater percentage more than 4
- Perform laboratory investigations to determine the shear parameters (c&Ø).

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