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SOIL STABILIZATION BY USING PLASTIC WASTE

SAQIB MOHAMMAD BHAT[1], BRAHAMJEET SINGH[2]
[1]Scholar, Civil Engineering Department, RIMT University Mandi Gobindgarh, Punjab (INDIA)
[2]Assistant Professor, Civil Engineering Department, RIMT University Mandi Gobindgarh, Punjab (INDIA)

ABSTRACT

Stabilization of soil refers to the process of enhancing the engineering features of soil, such as its strength and bearing capacity. Soil stabilisation also helps to reduce permeability and structural foundation settlement. To bear varied loads of the building or pavement, the subgrade soil must be strong enough to sustain these loads without failure; however, if the subgrade soil is not strong enough to hold the loads, it requires stabilisation to make it more acceptable for construction.

Plastic is one of the world's most often used materials, and its trash has been a threat to our ecosystem; this study advocates for the use of plastic waste as soil additions. This provides a method for disposing of plastic garbage while also minimising the amount of plastic waste in landfills.

For this propose a soil sample was mixed with 0.3%, 0.5% and 0.7% of plastic strips by weight and experiments were carried out and results compared with control sample with 0% plastic content. The tests included Atterberg limits, Standard proctor test, Unconfined compression test (UCS) and California bearing ratio (CBR).

The obtained results showed that unconfined compressive strength increased with the increase in plastic content from 0% to 0.7%. With respect to California bearing ratio test the value also increased with the increase in plastic content from 0% to 0.7%. The increase in plastic content increased the OMC and MDD from 0% to 0.5% but further increase in plastic content caused a decrease in both OMC and MDD.

The obtained results showed that the CBR value for 0.7% addition of plastic strips resulted in the most increase of strength for the stabilized soil. Therefore the use of plastic bottle waste as strips for stabilization of sub grade is suggested as an effective and economical solution for improving the geotechnical properties of soil and reducing the plastic pollution in the environment.

KEYWORDS: Soil stabilization, waste reduction, California bearing ratio (CBR), unconfined compressive strength (UCS), Atterberg limits

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1. INTRODUCTION

Soil is particularly significant in engineering projects, both in structures and roadways. Because soil bears the entire load of the structure, the stability of the soil is critical to the project's safety. Stable soils can withstand deformation caused by repeated or continuous load application, but less stable soils fail to withstand these deformations, ultimately resulting to project failure. The treatment of such less stable soils to improve their strength and resistance to volume change is known as soil stabilisation. Soil stabilisation improves both the strength and durability of the soil.

These are expressed quantitatively as compressive strength, shear strength, and bearing strength. Soil stabilisation tries to improve soil strength and resistance to water softening by connecting soil particles together, water proofing the particles, or a combination of the two. To ensure that soil stabilisation is cost-effective and based on functional requirements, first evaluate the deficient qualities of the soil and then select the best feasible soil stabilisation approach.Soil stabilisation has been around for a while, and there are various ways of soil stabilisation in use. The procedure of mixing cement with soil to stabilise the soil has been utilised in the past and is well proven, but due to the high cost of cement, it has been less acknowledged in recent times. Another reason for its decreased use in recent years is the negative environmental effects of its manufacture. This has resulted in the necessity for new options. These solutions must be both inexpensive and have a lower environmental impact than cement manufacture.Plastic waste management has been a major worry in the modern era, and in order to address this, plastic trash has found increased application in several sectors, including construction projects. The release of greenhouse gases such as methane and ethylene into the environment when plastic comes into contact with sunlight has had serious environmental implications. Many products, such as bottles and plastic bags, are causing various environmental difficulties; hence, using these materials for soil stabilisation is a viable strategy to address the environmental concerns they are causing. The use of plastic for soil stabilisation aids in the modification of qualities such as shear capacity and bearing strength.

1.1. Mechanical Stabilization

Mechanical stabilisation is another term for granular stabilisation. Proportion and compaction are the guiding ideas at work. This technique entails combining several types of soils with variable slopes. This is done in order to compact the soil bulk.

1.2 Chemical Stabilization

This technique achieves the desired soil qualities by incorporating chemically active compounds into the soil. Examples include lime, cement, bitumen, fly ash, and other soil stabilisers. This approach has been used to stabilise clayey soils. Lime boosts strength and rigidity while decreasing edoema and shrinkage. Pozzolanic ingredients are required for its activity in soil. It is made up of clay minerals and amorphous chemicals, and their absence renders lime stabilisation useless. The procedure of combining cement with soil to stabilise the soil has been utilised in the past and is well proven, but it has become less recognised in recent times due to the high cost of cement.The unfavorable environmental implications of its manufacture are another cause for its decreased use in recent years. Fly ash is a byproduct of coal-fired power plants and steam facilities. It is a common chemical stabiliser based on the pozzolana reaction that aids in the filling of voids in mixes. It is most effective with coarse-grained particles. PLASTIC CONTENT is made from blast furnace slag, a byproduct of iron production. It is mostly composed of silicate and aluminosilicate of molten calcium, which must be removed from the blast furnace on a regular basis. The composition of PLASTIC CONTENT is determined by the raw material used in the production of iron, whilst the physical qualities are determined by the cooling procedure used to cool molten material.

2. OBJECTIVES

1. To determine the optimum percentage of plastic strips for soil stabilization.
2. To evaluate the effects of percentage of plastic strip on geotechnical properties of Black Cotton soil such as California Bearing Ratio, unconfined compressive strength.

3. To evaluate the effects on optimum moisture content and maximum dry density.

3. MATERIAL & METHODOLOGY

3.1.1 SOIL

Soil samples were gathered from around our college campus and analysed for geotechnical qualities and strength. The soil type under investigation is black cotton soil, commonly known as expansive soils. It is one of India's main soil deposits, covering an area of approximately 3,00,500 square kilometres. BC dirt is a clayey soil that appears greyish and black. It comprises montmorillonite clay mineral, which has highly expensive properties. When exposed to changes in moisture content, they swell and shrink rapidly. Because of the high incidence of montmorillonite in this soil, cracks in the soil occur without warning, posing a risk to any construction projects, as this soil is directly connected to engineering structures.

Fig 1:Soil

3.1.2 Plastic waste

Plastic is also not biodegradable, which means it cannot be broken down into smaller molecules by nature and can live for hundreds of years. Because their qualities are generally linked to natural materials, using plastic waste bottles in geotechnical construction may lessen the challenges associated with their disposal. We discussed how we use plastic trash bottles in this chapter, as using these plastic bottles results in soil stabilisation. For this, we cut plain-surface bottles with dimensions of almost length 20mm and width 4mm and mixed in percentages of 0.3 percent, 0.5 percent, and 0.7 percent.

Fig 2: Plastic Waste Stripes

3.3 Methodology

Specific gravity, optimum moisture content (OMC), maximum dry density (MDD), unconfined compressive strength (UCS), and California Bearing Ratio (CBR) values were determined in the laboratory.

Table 1: Properties of soft soil

Soil properties	Description
Liquid limit	59.14
Plastic limit	20.05
Plasticity index	39.09
Optimum moisture content	14.3
Maximum dry density	1.71
CBR value (soaked)	2.04
CBR value (unsoaked)	5.90
Specific gravity	2.34
Shear strength	1.19

After that we mixed the Plastic waste strips with the different proportion (such as 0.3 %, 0.5 % and 0.7 % of dry weight of soil) and found out the physical properties of mixed soil compare the observations that obtained.

Table 2: Combinations of additive with soil

S no	Soil (%)	Plastic waste strips (%)
1	99.7	0.3
2	99.5	0.5
3	99.3	0.7

4. RESULTS AND DISCUSSION

4.1 Effect of compaction properties

Maximum dry density (MDD) and optimum moisture content (OMC) of all trial mixtures were determined in the laboratory in accordance with IS: 2720 (Part 8) - 1983.

Optimum moisture content and maximum dry density were found and then at varying percentages of 0.3%,0.5% and 0.7% various tests were performed and there results compared with test results of samples with 0% of plastic content. The increase in the plastic content caused an increase in the OMC from 14.3% for 0% plastic content to 16.3% for 0.5% plastic content after that the increase in plastic content to 0.7% caused an decrease in the OMC.The increase in plastic content caused an increase in OMC from 1.71 at 0% plastic content to 1.89 at 0.5% plastic content and further increase in plastic content to 0.7% caused an decrease in MDD.

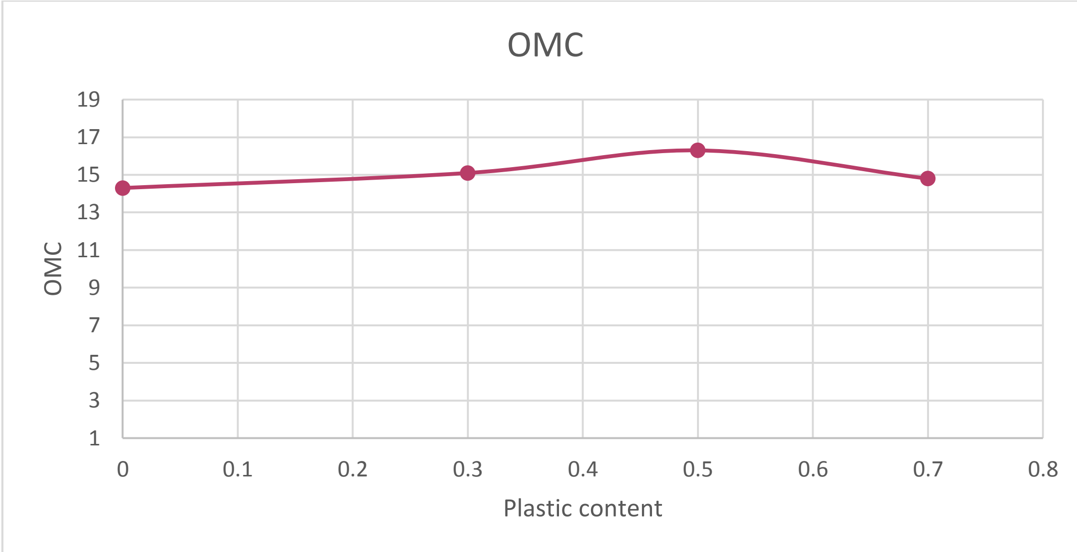

Fig 4: OMC and plastic content graph

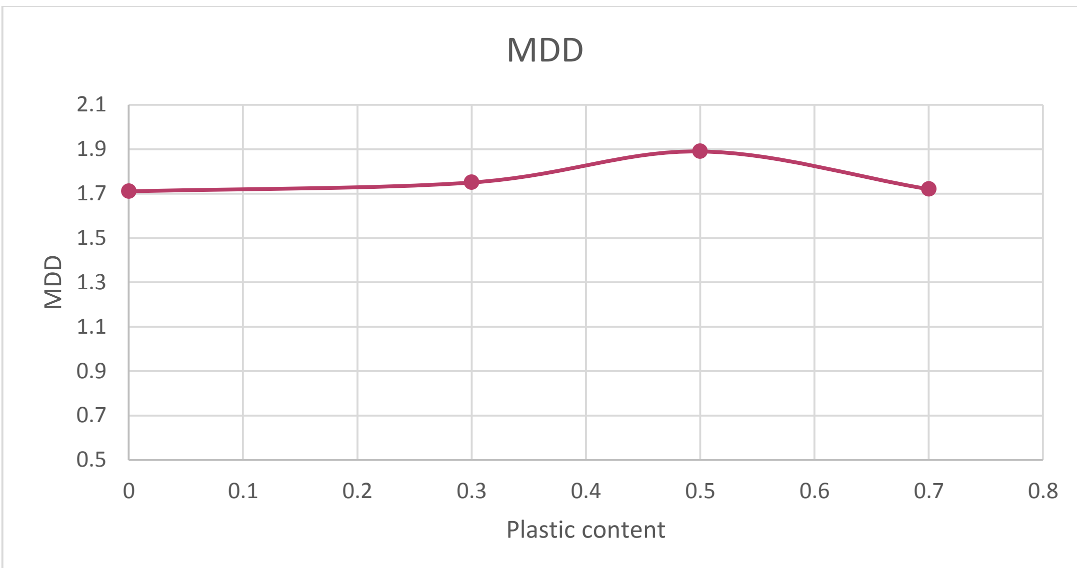

Fig 5: MDD and plastic content graph

4.2 Effect of Shear strength

Shear strength is the internal resistance to failure or deformation caused by continuous shear displacement of soil particles. Unconfined compression test was carried out to find the shear strength of soil sample. The test was carried out with 0.3%, 0.5% and 0.7 % percentages of plastic content mixed with soil.

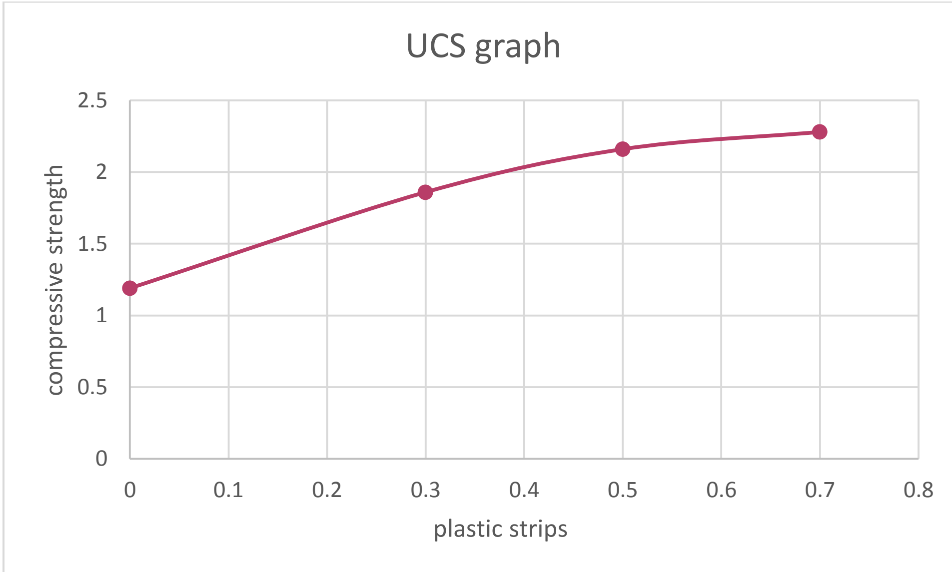

Fig 6: compression strength and plastic content Graph

We performed the unconfined compressive strength test, at 0%, 0.3 %, 0.5% and 0.7 %. The value for compressive strength for 0 % addition of plastic wastes was 1.19 kg/ cm^2, when we add 0.3% of plastic strips the compression strength becomes 1.86 kg/ cm^2 which is an increase of 56.3%. The percentage of addition of plastic strips is increased to 0.5% and the value of compressive strength increases to about 2.16kg/ cm^2 which is an increase of 81.5%. When we further increase the addition of plastic wastes to 0.7% then compressive strength becomes 2.28 kg/ cm^2 which is an increase of 91.5%.

4.3 Effect of CBR

The analysis was performed for the following percentages of mixed GGBS: 0%, 0.3 %, 0.5% and 0.7 %. The specimens have been compacted at their OMC and MDD from the Proctor test, and the test was run until 12.5mm of penetration was achieved. The test was performed on both soaked and unsoaked samples.

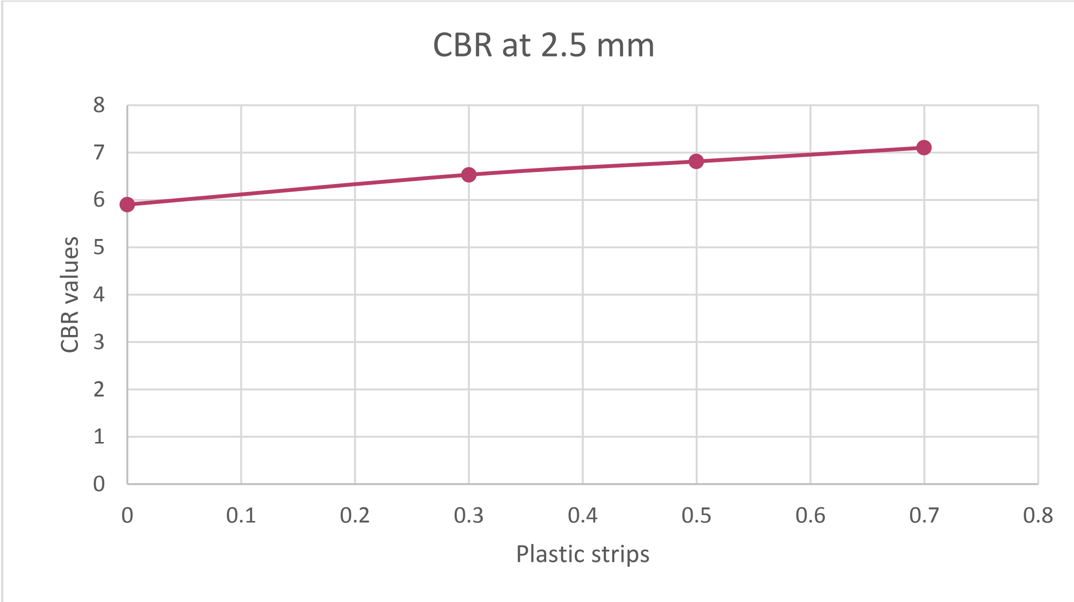

Fig 7: CBR value vsplastic content Graph for unsoaked condition for 2.5 mm

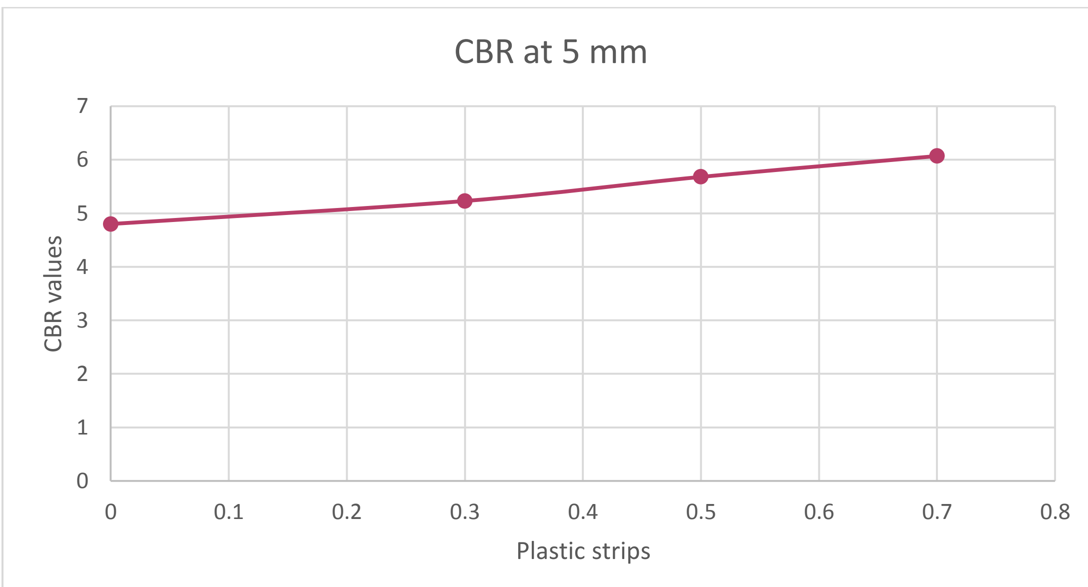

Fig 8: CBR value vsplastic content Graph for unsoaked condition for 5mm

We performed California bearing ratio test, at 0%, 0.3 %, 0.5% and 0.7 %. These values are for unsoaked conditions. The value for CBR for 0 % addition of plastic wastes was 5.90 %, when we add 0.3% of plastic strips the value becomes 6.53%, which is an increase of 10.67%. The percentage of addition of plastic strips is increased to 0.5% and the value of CBR increases to about 6.81 which is an increase of 15.42 %. When we further increase the addition of plastic wastes to 0.7% then CBR becomes 7.10 which is an increase of 20.33%.

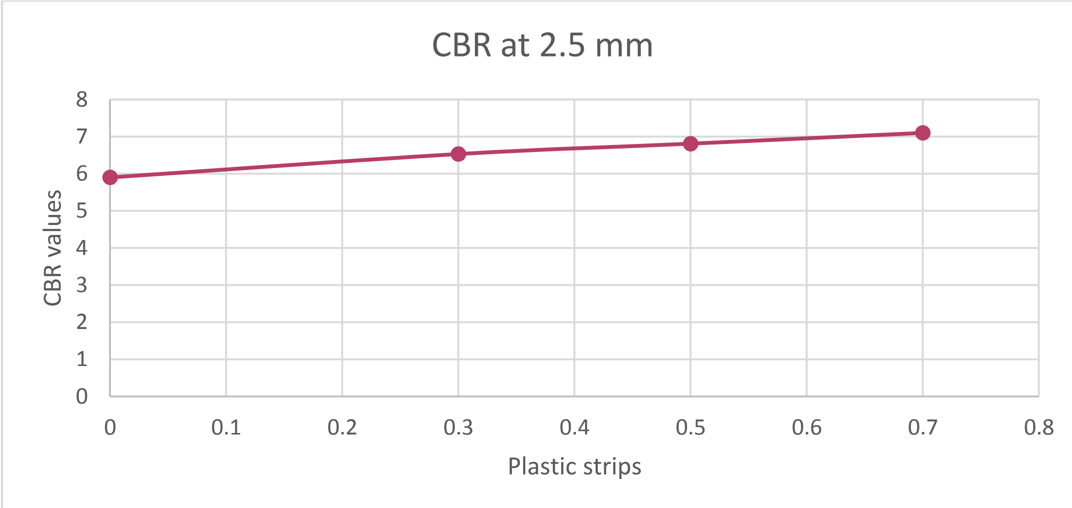

Fig 9: CBR value vsplastic content Graph for soaked condition for 2.5mm

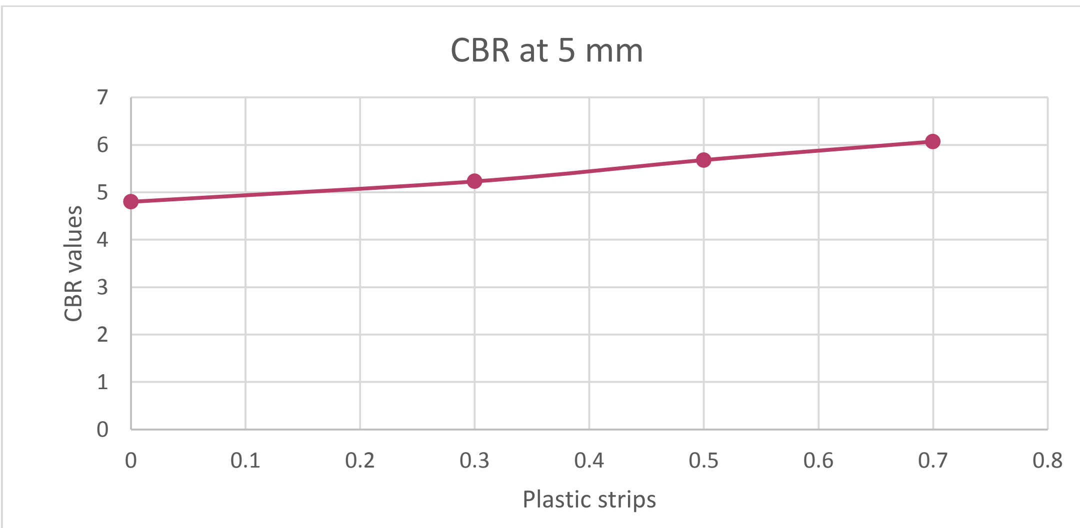

Fig10 : CBR value vsplastic content Graph for soaked condition for 5mm

We performed California bearing ratio test, at 0%, 0.3 %, 0.5% and 0.7 %. These values are for soaked conditions. The value for CBR for 0 % addition of plastic wastes was 2.04 %, when we add 0.3% of plastic strips the value becomes 2.92%, which is an increase of 45.09%. The percentage of addition of plastic strips is increased to 0.5% and the value of CBR increases to about 3.24 which is an increase of 58.82 %. When we further increase the addition of plastic wastes to 0.7% then CBR becomes 3.86which is an increase of 89.21%.

5. CONCLUSION

The growth in plastic waste has been deteriorating for our environment and in many cases has caused irreversible damage to our environment and to prevent any further damage it is our responsibility to find better ways to dispose these wastes in a way that is beneficial to us. So as engineers our main goal is to use these waste materials as recyclable materials, therefore this thesis employed the use of plastic waste to stabilizing agent. For this purpose, various tests like compaction, compression and CBR were conducted on the soil samples that were collected both with and without soil percentages.

Optimum moisture content and maximum dry density were found and then at varying percentages of 0.3%,0.5% and 0.7% various tests were performed and there results compared with test results of samples with 0% of plastic content. The increase in the plastic content caused an increase in the OMC from 14.3% for 0% plastic content to 16.3% for 0.5% plastic content after that the increase in plastic content to 0.7% caused an decrease in the OMC. The increase in plastic content caused an increase in OMC from 1.71 at 0% plastic content to 1.89 at 0.5% plastic content and further increase in plastic content to 0.7% caused an decrease in MDD.

While performing the CBR test in both soaked and unsoaked conditions it was observed that the value of CBR goes on increasing from 5.91% at 0% plastic content to 7.10 % at 0.7% plastic content. Thus the optimum percentage of plastic content which has the most CBR value is 0.7%.

While performing UCS test it was observed that the compression strength goes on increasing from 1.19% at 0% plastic content to 2.28% at 0.7% plastic content.

Soil stabilization is the process by which engineering properties of unstable soils such as its strength and bearing strength are increased to make them suitable for construction use.

Adding plastic to soil not only improve these properties but also help in the disposal of these wastes.

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