Effect of PET Bottles (Powder) on Different Properties of Black Cotton Soil

Gorad Chandrakant M.[1], Karne Amar Nandkumar[2], Mhetre Rushikesh Dattatray[3], Kale Pratik Shivaji[4], Sonwalkar Rohit Bajirao[5], Khatal Shubham Baban[6].

[1]*Assistant Professor, Dept. of civil engineering, College of Engineering, Phaltan, Maharashtra, India.*
[2,3,4,5,6] *Student, Dept. of civil engineering, College of Engineering, Phaltan, Maharashtra, India.*

Abstract - *Soil is a very important part of the earth's ecosystem. However, the earth is becoming increasingly polluted as a result of human waste plastic dumping. For engineering purposes, black cotton soil is a difficult material to stabilize due to its great capacity for shrinking and swelling as a result of changes in moisture content. When compared to other types of soil, it will reduce the stability and shear strength of black cotton soil.*

This project study describes the stabilization of black cotton soil using PET (Polyethylene Terephthalate) powder, which is effectively used to address societal concerns such as reducing plastic waste and improving soil physical qualities such as shear strength Moisture content. PET (Polyethylene Terephthalate) powder is used in different proportion 0%, 0.2%, 0.4%, 0.6%, 0.8% and 1%. Then index Properties test, Standard Proctor, Moisture Content and Direct shear test are conducted to find the properties of soil which will increases the strength of soil.

***Key Words*: Soil Stabilization, Black Cotton Soil, Plastic waste, PET Bottle's powder, Compaction test, Direct shear test, etc**

1. INTRODUCTION

Soil stabilization a general term for any physical, chemical, mechanical, biological, or combined method of changing a natural soil to meet an engineering purpose.

Black cotton soils are beneficial to agriculture, but they have shown to be a major threat to structures built on them. These soils have a high swelling capacity due to water ingestion during the monsoon season and a low shrinkage capacity due to evaporation during the summer season. The presence of the mineral montmorillonite is responsible for the swelling and shrinkage. The constructions built on these soils incur fissures as a result of the significant swelling and shrinking, rendering them unsuitable for foundation. As a result, there is a need to improve the strength of black cotton soil so that it can be used as a foundation material.

To improve soil strength values, soil stabilization with plastic trash can be used in embankments and road pavement layers. The use of plastic garbage to stabilize the soil produced an unusual result, with an increase in soil strength parameters assessed in several experiments. However, some researchers claim that the results vary depending on the kind of soil, and that waste plastic stabilization may reduce some strength values.

2. OBJECTIVES

- To conduct Direct Shear Test (DST), Optimum Moisture Content (OMC), Maximum Dry Density (MDD), consistency (Liquid limit, Plastic limit, Shrinkage limit) and sieve analysis of soil.
- To conduct Direct Shear Test (DST), Optimum Moisture Content (OMC), Maximum Dry Density (MDD), consistency (Liquid limit, Plastic limit, Shrinkage limit) and sieve analysis for 0%, 0.2%, 0.4%, 0.6%, 0.8% and 1% of plastic powder.
- Comparison between different percentage.

2.1 Scope of Project

The scope of present work includes addition of plastic bottle powder to the locally available soils to enhance the engineering properties. The work presented in this paper aims to investigate the improvement of soil properties such as shear strength, maximum dry density OMC, MDD and Direct Shear strength values by adding powder from plastic bottles. A series of laboratory tests are conducted on both untreated soils as well as on plastic reinforced soil to compare the improvement of soil properties. List of experiments conducted in laboratory as per IS Codes.

3. MATERIALS

Black Cotton Soil

Soil used for project is taken fromnA/p Kambleshwar Tal

– Phaltan Dist – Satara. Which is about 10 km from PES's College of Engineering, Phaltan. The soil is collected from certain ground level. The disturbed soil sample is then transported to the geotechnical laboratory of PES's COE Phaltan.

Table -1: Properties of Black cotton soil

Sr. No.	Properties	Result
1	Water Content	8.92%
2	Sieve Analysis	Gravel Soil
3	Plastic Limit	43.33%
4	Liquid Limit	26.2%
5	Shrinkage Limit	13%

Waste PET Bottles

The Waste PET bottels are collected from nearest area. PET (Polyethylene Terephthalate) is a plastic made from petroleum hydrocarbons and formed by a reaction between ethylene glycol and Terephthalate acid. It is recognised as a good additive for soil stabilisation to improve the engineering qualities of soil due to its superior wearing resistance, low coefficient of friction, and high flexural modulus. PET's chemical formula is (C10H8O4) n.

Table -2: Properties of PET

Sr. No.	Properties	Result
1	Melting Point	260^{0}C
2	Tensile strength	152MPa
3	Flexural strength	221MPa
4	Specific gravity	1.56Kg/m^3
5	Shrink rate	0.1-0.3%

4. METHODOLOGY

4.1 Preparation of Soil sample

Soil sample as received from the field shall be dried in the air or in sun. In wet weather a drying apparatus may be used in which case the temperature of the sample should not exceed 60°C. The clods may be broken with a wooden-mallet to hasten drying. The organic matter, like tree roots and pieces of bark should be removed from the sample. Similarly, matter other than soil, like shells should also be separated from the main soil mass. A noting shall be made of such removals and their percentage of the total soil sample noted.

4.2 Preparation of PET Powder

The bottles had melted and cooled down a bit then the melted bottles are grinded in mixer.

Figure - 1: Preparation of PET Powder

4.3 Tests

Compaction test -

Compaction is the process of densification of soil mass by reducing air voids. The purpose of laboratorycompaction testis 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 obtained after compaction are plotted both to arithmetic scale, the formeras abscissa and the latter as ordinate. The points thus obtained are joined together as a curve. The maximum dry densityand the corresponding OMC are read from the curve.

Direct Shear Test-

Shear strength of a soil is the resistance to shearing stress at failure on the failure plane Shear strength is composed of:

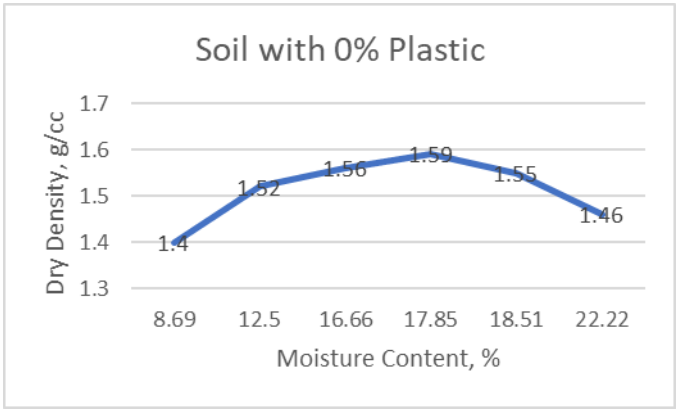
Internal friction which is the resistance due to friction between individual particles at their contact points and interlocking of particles. This interlocking strength is indicated through parameter (φ).

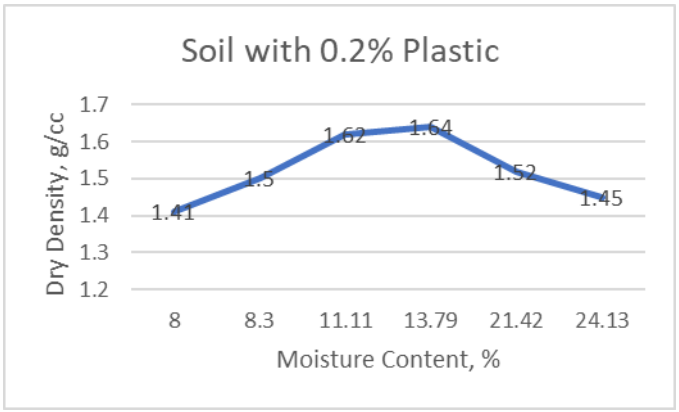
Cohesion which resistance due to inter-particle force which tend hold the particles together in a soil mass. The indicative parameter is called Cohesion intercept (c).

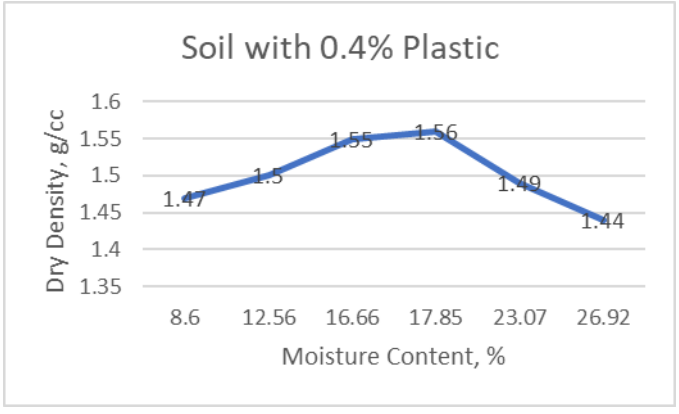
Table -3: Test results

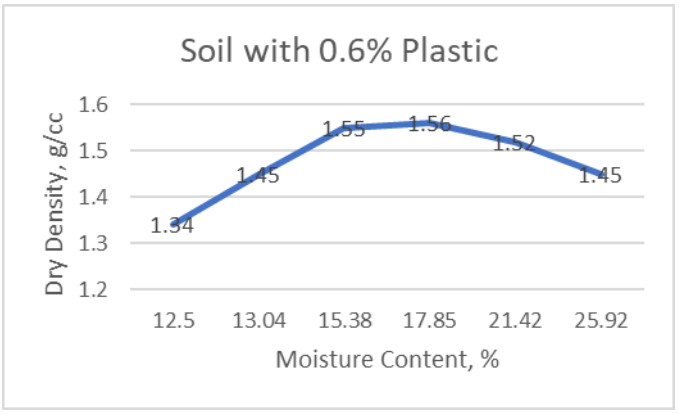
Tests	OMC (%)	MDD (g/cc)	Shear strength (kN/m²)
Soil with 0% PET Powder	17.7	1.59	43
Soil with 0.2% PET Powder	13.79	1.64	74
Soil with 0.4% PET Powder	17.9	1.56	61
Soil with 0.6% PET Powder	17.5	1.56	66
Soil with 0.8% PET Powder	22.3	1.52	53
Soil with 1% PET Powder	20	1.51	46

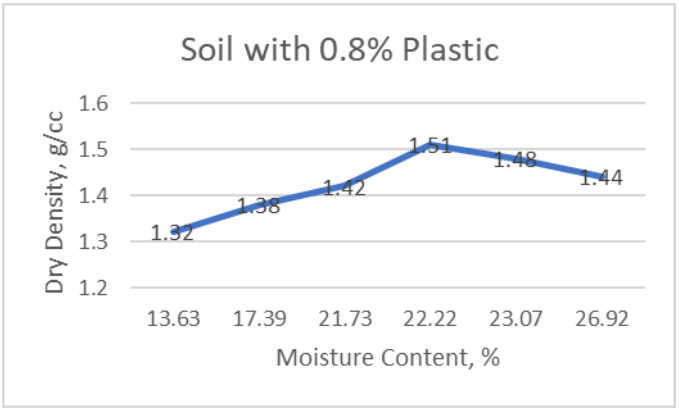
5. RESULT COMPARISION











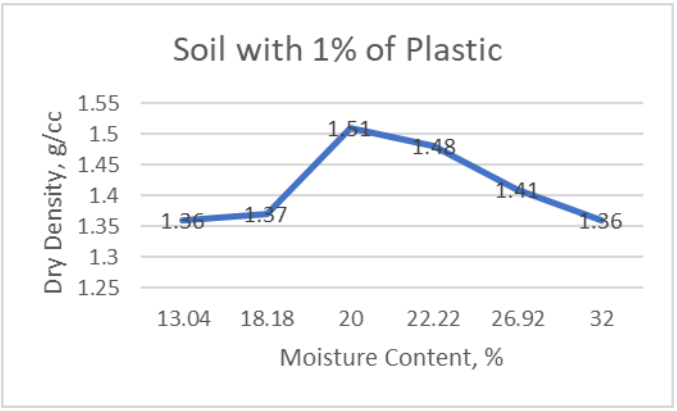


Chart -1: Comparison graphs of OMC & MDD results

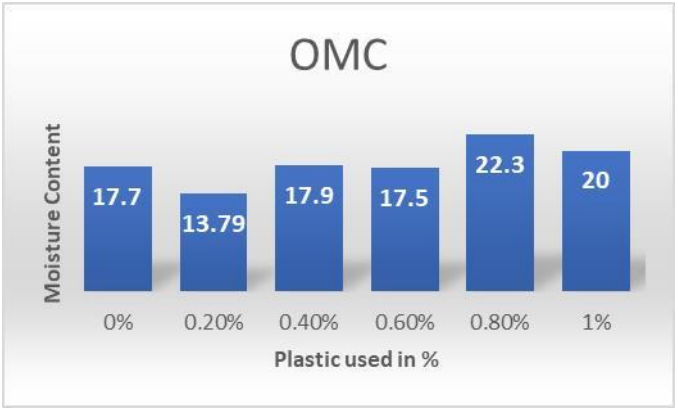


Chart -2: Variation in Optimum Moisture Content

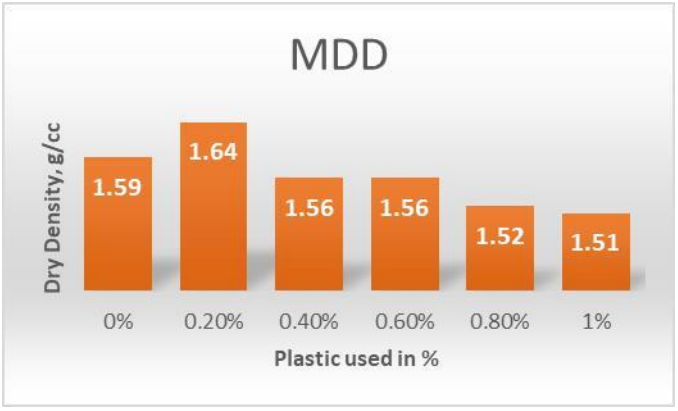


Chart -3: Variation in Maximum Dry Density

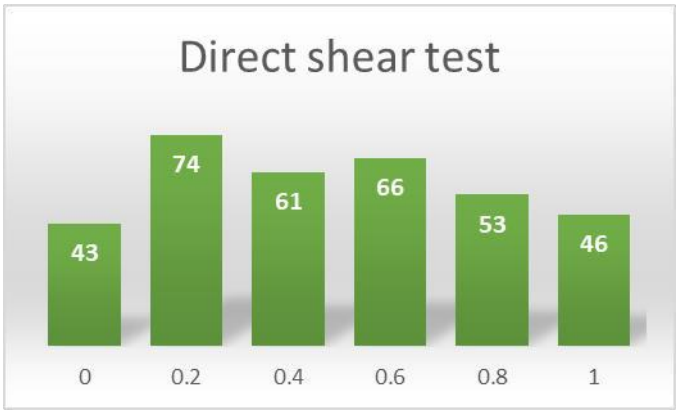


Chart -4: Variation in Direct Shear Stress

6. CONCLUSIONS

Plastic bottles, polythene and other plastic things are becoming increasingly popular in today's world. For us, disposal of this plastic has become a major task. As a result, combining plastic with Soil becomes a cost-effective and environmentally friendly way to dispose of waste. Soil stability, as well as plastic. In the soil, PET powder is used. different percentages and analyze various soil test results The following conclusion has been reached:

Maximum dry density increases from 1.59 to 1.64 g/cc and Optimum moisture content decrease from 17.7% to 13.79% at 0.2% PET powder.

On the increasing the percentage of PET powder in the soil, Dry density starts decreasing and Optimum moisture content starts increasing.

Direct shear stress value increases from 43 kN/m^2 to 74kN/m^2 at 0.2% PET powder.

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