Experimental study on the improvement of soil by using waste plastic Bottles

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Abstract: Soil modification is the expansion of a modifier to dirt to change its various properties, while soil stabilization is the treatment of soils to empower their quality and sturdiness to be improved with the end goal that they turn out to be absolutely reasonable for development past their unique arrangement. Stabilization of soil which is commonly extraordinary kind of fiber. For this project I have selected the use of waste plastic PET bottles of cold drinks which are generally found available as waste in abundance in every nook and corner of not only in our country but in the whole world as these days everyday is found of consuming it as a food. After consumption all the empty bottles are thrown into the waste baskets or in the open. These are not recyclable and create hazards in the environment and to leaves a huge adverse impact on the health of people. If these empty bottles are reused as a construction material instead of being burnt or disposed of in any other way. Their unique properties once again can be exploited in a beneficial manner. The increase in cost of construction material and the scarcity of raw material motivated the researchers and planners to find waste material or substitute material that are environmentally friendly and economically sustainable. In this study the various percentages of waste plastic bottles strips 0.2%, 0.4%, 0.6%, and 0.8 %. having size less than 0.5 mm.

Keywords: Soil Stabilization, Unconfined Compressive strength, CBR Value, Plasticity.

1.1 INTRODUCTION

Soil stabilization is any process which improves the engineering properties of soil, such as increasing shear strength, bearing capacity etc. Shear strength is the term used in soil mechanics, to describe the magnitude of the shear stress that a soil can sustain. The shear resistance of soil is resulted from the friction between particles, interlocking of particles, and possibly cementation or bonding at particle contacts. And bearing strength can be geotechnical be defined as capacity of soil to support the loads applied to the ground without causing failure. Thus bearing capacity of soil is the maximum average contact pressure between the foundation and the soil which should not produce shear failure in the soil. 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 rely 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 rely on chemical additives of one sort or another, frequently encountered compounds are utilization of cement, lime, fly ash, or kiln dust. Plastic is a non-renewable source and bio-degradable. The disposal of waste plastic bottles causes environmental pollution, it's a sustainable waste. Plastic can be recycled or reused i.e. reprocessing these plastic wastes makes the useful products. Such wastes of plastics be used as additives for stabilized soil. Waste plastic materials are reused because it can be remoulded /recycled by no. of times, thus wastage is reduced. Uses of these plastic wastes for improving the properties of soil, effective method of stabilization. Inversely the soil shears strength and load bearing capacity. Uses of plastic materials are increased day by day; vice-versa disposal of plastic increases the waste plastic material in municipal soild waste.

1.2 LITERATURE REVIEW ON WASTE PLASTIC

Jaswinder Singh et al reviewed on the Improvement of Engineering Properties of soil Using Waste Plastic Bottles Strips. This reviews structured to illustrate the value added to foundations by the use of geosynthetic reinforcement. In especial, the review is designed to illustrate the benefits derived from waste polypropylene fiber reinforcement, the conditions under which reinforcement is good, the polypropylene properties that are most influential for this application, and the mechanisms responsible for reinforcement. The ends of this unit are used subsequently to evaluate existing design procedures, to comment on developing application specifications. And it can be it can be concluded that there is a dire need to utilize the waste plastic (PET) collect from various sources the waste all over the counter for the stabilization of soil which will help to the most extent to decrease the requirement of valuable land for their disposal and also reduce the hazardous environmental impacts.

Sushovan Dutta et al did the review study on the Use of Waste Plastic Bottles and Fly Ash in Civil Engineering Applications. In this study, Laboratory strain controlled compression tests were carried out on the cells rested over a rigid base and filled with compacted fly ash or stone aggregates. Test results showed significant load carrying capacity of the composite cells with fly ash as infill material. Though fine fly ash appeared to be an effective infill material, use of coarse stone aggregates as infill material produced better load carrying capacity of the composite cells. It was also observed that with reduction in cell height over the rigid base, load carrying capacity of the composite cells got increased. The study confirmed that plastic bottles with suitable infill material can act as an ideal compression member. As all the tests have been carried out on a rigid base, deformation of the base did not take place. Only the bottle cells deformed and failed after reaching its ultimate failure state under a very high compressive pressure. It does not simulate the tests on soft foundation soil base where the soil base will also deform along with the encasements and consequently, the system will fail at a lower pressure compared to the present investigation.

M. A. Mohammed et al evaluated the effect of plastic bottle (pet) waste on stabilization of clay. This study has been carried out to evaluate the effect the plastic waste on stabilization of clay soil to improve the compressive strength of soil. An experimental program was conducted to investigate the effect of Plastic bottle waste (PET) and evaluate the efficiency on clay soil as stabilizers. A series of laboratory compaction and triaxial tests were carried. Plastic bottles waste (PET) with length (5 – 10 mm) was used as reinforcement. Soil specimens were compacted at maximum dry density with different percentage of plastic bottle reinforcement 0.5, 1.5, 3, 6, 12 and 15 % of weight of clay soil). Results indicate that an increasing of plastic bottle content decrease the maximum dry density and increase the OMC. The highest increase in strength value was achieved when the soil reinforced with 1.5 % of plastic bottle, According to the laboratory tests conducted to investigate the effect of using the various percentages of waste plastic bottles as reinforced material to improve the strength behavior of clay soil and concluded that, For soil reinforced by plastic PET bottle waste the results indicate that the maximum dry density decreased with the increase in the PET content from 1.50 g/cm^3 to 1.08 g/cm^3, which is due to lower density of PET compare to the soil particles. Also an increasing of PET bottle waste content decreased the optimum moisture content from 27% to 35%.

N. Vijay Kumar et al studied on the Soil Stabilization Using Plastics and Bottle Strips. In this study, a review paper is presented here to focus on soil stabilization by using waste plastic products. The tests such as liquid limit, plastic limit, standard proctor compaction test, California bearing ratio (CBR) test and unconfined compressive strength (UCS) have been conducted to check the improvement in the properties of black cotton soil. This paper reviews the work of various researchers on stabilization of soil and use of plastic and bottle strips materials in improving its strength. The compaction tests were done to assess the amount of compaction and the water content required. The water content at which the maximum dry density is attained is obtained from the relationships provided by the tests. The California Bearing Ratio test is conducted for the soil by adding plastic strips with varying percentage of 0.2 i.e.0.2%, 0.4%, 0.6% etc. and determines the strength of soil until the strength reaches the highest level and stop at the interval when strength decreasing from the highest. Thus this study is to meets the challenge of society to reduce the quantities of plastic waste, the plastic stripes were made out of this plastic wastage and are used in making the payment and it is found that there is an increase in the strength of the soil. California Bearing Ratio test was carried out to find the maximum dry density and optimum moisture content.

1.3 PREPARATION OF REINFORCED SOIL SAMPLES

Plastic PET bottle wastes and soils were prepared manually by hand mixing. Oven dried soil after passing through4.75 mm sieve was taken and water added for clayey soil and mixed uniformly. For a particular percentage of fiber content, the 1/3 rd of total amount of plastic strips were distributed evenly and mixed thoroughly with wet soil. After mixing the 1/3rd amount, another 1/3rd amount were mixed in the same way.

Lastly the rest 1/3rd amount was mixed with the wet soil. The wet plastic-mixed soils were then used for proctor tests and triaxial tests. Following Mixes are made for the testing process:

1. M 1- Soil sample
2. M 2- Soil sample + 0.2% waste Plastic
3. M 3- Soil sample + 0.4% waste Plastic
4. M 4- Soil sample + 0.6% waste Plastic
5. M 5- Soil sample + 0.8% waste Plastic

1.4 STANDARD PROCTOR TEST

This project uses the Standard Proctor's test to determine the dry density of the soil sample. In the Standard Proctor Test, a standard volume (944cc) is filled up with soil in three layers. Each layer is compacted by 25 blows of a standard hammer of weight of 2.495 kg (5.51lb), falling through 304.8mm (12").Knowing the wet weight of the compacted soil and its water content, the dry unit weight of the soil can be calculated. The optimum moisture content and Maximum Dry density is given in table 1 and figure 1 and 2.

Table 1: Maximum Dry Density and Optimum moisture Content

Sr. No	Mix	OMC (%)	MDD (gm/cc)
1	**M 1- Soil sample**	21.82	1.74
2.	**M 2- Soil sample + 0.2% waste Plastic**	23.86	1.85
3.	**M 3- Soil sample + 0.4% waste Plastic**	25.52	1.82
4.	**M 4- Soil sample + 0.6% waste Plastic**	26.35	1.79

5.	**M 5- Soil sample + 0.8% waste Plastic**	26.57	1.74

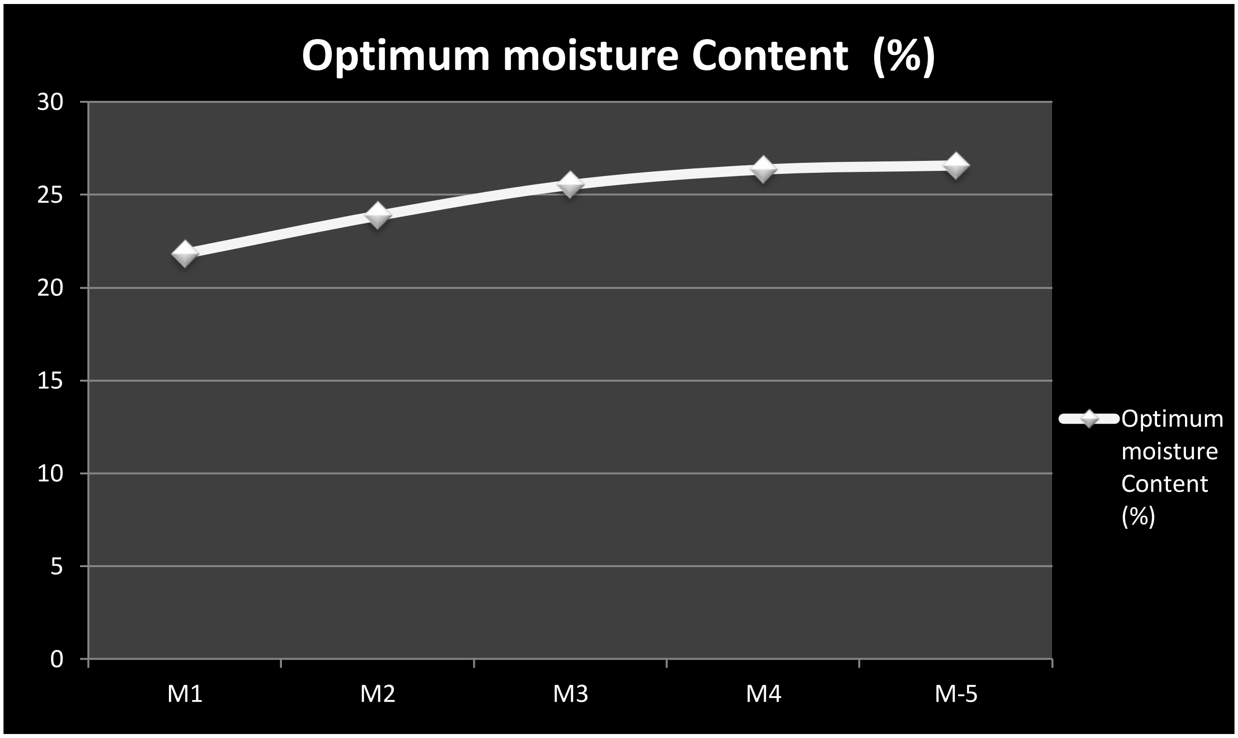

Figure 1: Effect on Optimum moisture Content by using different proportions of Waste Plastic

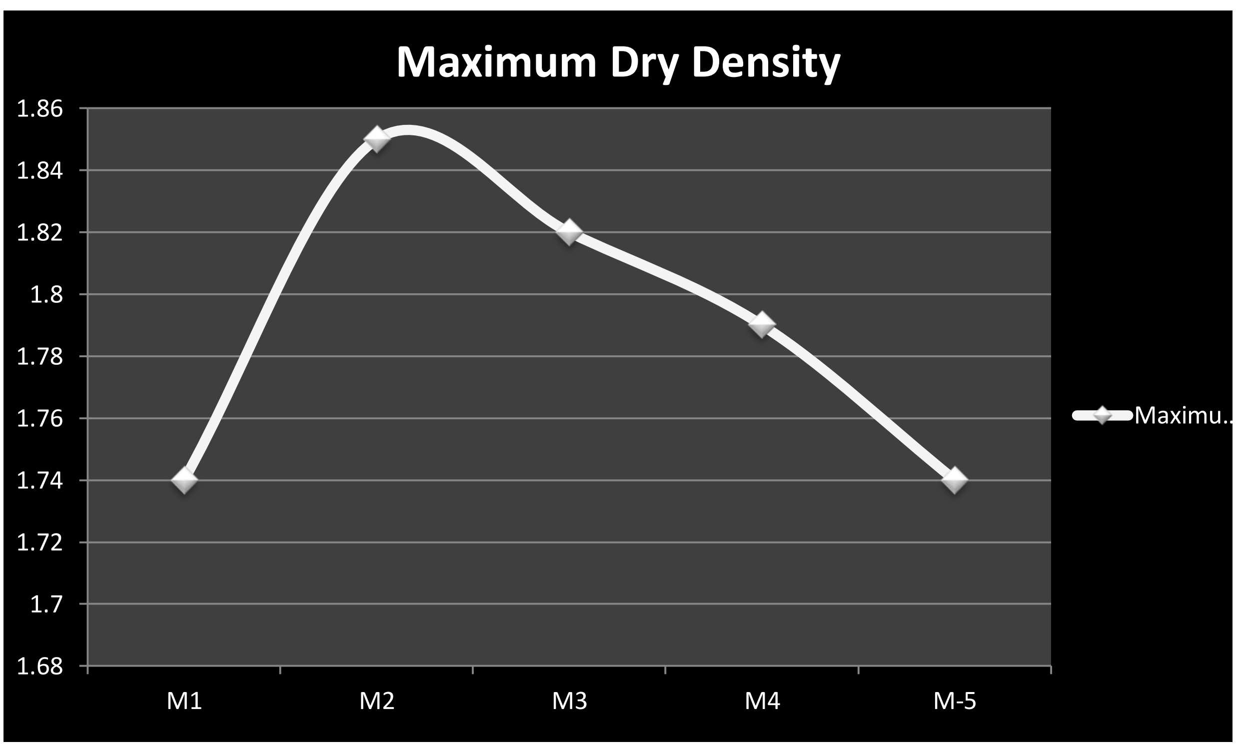

Figure 2: Effect on Maximum Dry Density by using different proportions of Waste Plastic

1.5 UNCONFINED COMPRESSIVE STRENGTH

The most important property for a weak soil deposit is its compressive strength which gives a measure of the load it can take before it fails. The test was carried out after the specimen was moist cured for 7 and 28 days.

Table 2: Unconfined Compressive strength

Sr. No	Mix	UNCONFINED COMPRESSIVE STRENGTH (KN/m^2)	
		7 Days Curing	28 Days Curing
1	**M 1- Soil sample**	137.57	193.77
2.	**M 2- Soil sample + 0.2% waste Plastic**	228.92	336.31
3.	**M 3- Soil sample + 0.4% waste Plastic**	245.23	357.86
4.	**M 4- Soil sample + 0.6% waste Plastic**	212.93	293.43
5.	**M 5- Soil sample + 0.8% waste Plastic**	187.45	284.40

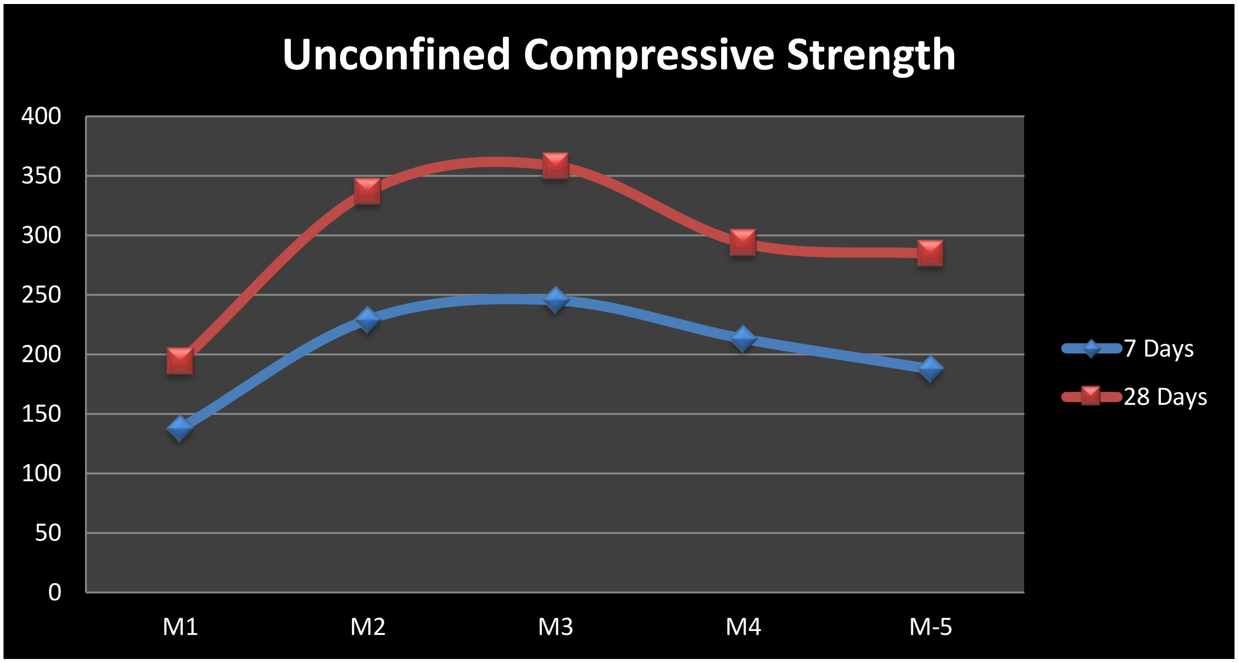

Figure 3: Effect on Unconfined Compressive strength by using different proportions of Waste Plastic

1.6CALIFORNIA BEARING RATIO (CBR) TEST

The California bearing ratio (CBR) is a penetration test for evaluation of the mechanical strength of road sub grades and base courses. It was developed by the California Department of Transportation. CBR is defined as the ratio of force per unit area required to penetrate a soil mass with a circular plunger of 50mm diameter at the rate of 1.25mm/min to that required for corresponding penetration of a standard material. The ratio is usually determined for penetrations of 2.5mm and 5mm. When the ration of 5mm is consistently higher than at 2.5mm, the ratio at 5mm is used. Standard load is defined as the load obtained from the test on crushed stone which has a CBR value = 100%.

Table 3: CBR Variation for both soaked and unsoaked

Sr. No	Mix	Unsoaked	Soaked
1	**M 1- Soil sample**	3.26	8.86
2.	**M 2- Soil sample + 0.2% waste Plastic**	5.63	12.76
3.	**M 3- Soil sample + 0.4% waste Plastic**	5.98	13.21

4.	**M 4- Soil sample + 0.6% waste Plastic**	6.53	13.69
5.	**M 5- Soil sample + 0.8% waste Plastic**	6.40	13.09

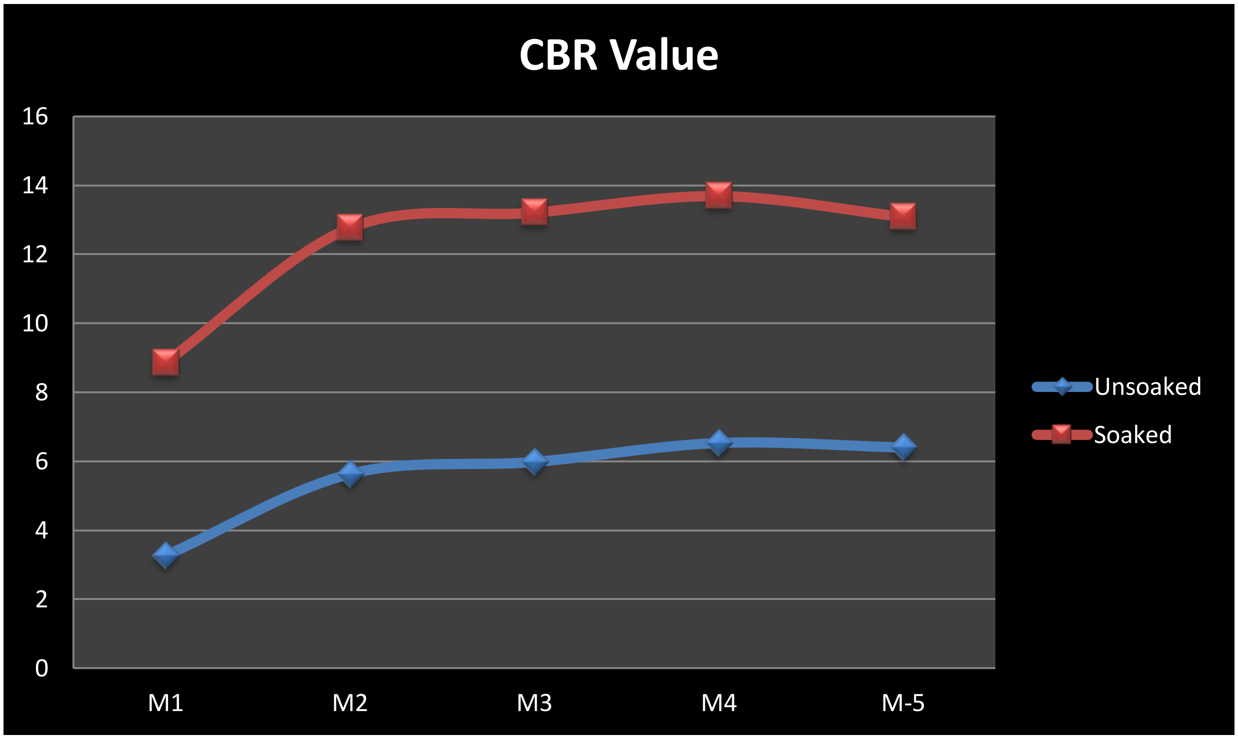

Figure 4: Effect on CBR Value by using different proportions of Waste Plastic

CONCLUSION

After discussing the various literature studies and experimental work, following conclusions are drawn in this study:

1. The maximum CBR value is achieved at the Mix 4 having 0.6% Waste Plastic.
2. The maximum Unconfined Compressive strength is achieved at the Mix 4 having 0.6% Waste Plastic.
3. The optimum content of waste plastic bottle strips is 0.6 %.
4. There is a dire need to utilize the waste plastic (PET) collect from various sources the waste all over the counter for the stabilization of soil which will help to the most extent to decrease the requirement of valuable land for their disposal.
5. For soil reinforced by plastic PET bottle waste the results indicate that the maximum dry density decreased with the increase in the PET content after 0.2 %
6. The study shows an easy way of recycling the waste plastic water bottles as reinforcement materials in the field of Geotechnical engineering.

7. The liquid limit of the soil Increases by increasing the waste plastic in soil.

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