RESEARCH ARTICLE OPEN ACCESS

Effect of Plastic Granules on the Properties of Soil

Mercy Joseph Poweth**,Femeeda Muhammed Haneef*,Melvin T Jacob*,Remya Krishnan*,Sheethal Rajan*
* (Civil Engineering VIII Semester Students, Mar Athanasius College of Engineering, Kothamangalam
Email: femeeda.91@gmail.com, melvintjacob000@gmail.com,remyaakrishnan50@gmail.com,)
** (Professor, Department of Civil Engineering, Mar Athanasius College of Engineering, Kothamangalam)

ABSTRACT
This work presents a study on the effect of plastic granules on the properties of soil. Utilizing the waste plastic as granules in the soil solves the problem of disposing the waste and it does not show any considerable reduction in the strength of soil. Experiments were done by taking an available weak soil as sample. These tests are conducted on soil with varying percentage of plastic granules and without adding it and comparing those results. Data presented includes dry density, shear strength, CBR value, permeability. The experiment reveals that properties of the soil does not change considerably. The proposed technique can be used as an effective method to dispose the waste plastic.
Keywords: Dry density, shear strength, permeability.

I. Introduction

Plastics are considered as one of the important invention which has remarkably assisted in different aspect of life whether it might be in scientific field or others. It is the fact that we can reuse the plastic and make it usable for number of times so that its wastage will be reduced remarkably. So it can be used for the alternative method where its important will be counted and stabilization of soil is the best place where this material can be used up. Plastic waste when mixed with soil behaves like a fibre reinforced soil. Plastic-waste materials are produced plentifully such as polyethylene terephthalate (PET) plastic bottles, polypropylene (PP) of plastic sack, and polypropylene (PP) of carpet. But such materials have been used little for engineering purposes. These plastic wastes in the form of granules and mixed with soil and the behaviour of the soil is similar to fibre reinforced soil. Plastic fibres/ granules are distributed throughout a soil mass. Hence uses of plastic waste for improving the engineering properties of soil are taken up in the present study. Preliminary experiments show that addition of plastic waste pieces lead to an improvement in strength response and there is a need to do detailed studies in this direction.

On the other hand, they are otherwise considered unsuitable and if found effective can also reduce the problem of disposal of this non biodegradable waste. In this paper we have studied the effect of plastic granules on the properties of soil. We have done general study on soil sample and according to results of Compaction test, CBR test, Direct shear test, permeability test we have arrived at conclusion.

II. Literature Review

A.K. Choudhary, J.N. Jha and K.S. Gill **[1]** studied on the feasibility of reinforcing soil with strips of reclaimed HDPE. Strips of HDPE were mixed with local sand and tested to determine CBR values and secant modulus. The tests show that reinforcing sand with waste HDPE strips enhances its resistance to deformation and its strength.
Prof. G L Sivakumar Babu **[2]** carried out an experimental investigations on fly ash mixed with plastic waste and geogrid waste and their effect on the seepage potential and piping resistance. It improves the piping resistance of the fly ash and is cost effective.

As per Mohammad M. Khabiri **[3]**, when the waste carpet are added to soil and granular materials their various properties as compressive and tensile strength are improved.

Pragyan Bhattarai, A. V. A Bharat Kumar, K. Santosh, T. C. Manikanta & K. Tejeswini**[4]** suggested that expensive methods for stabilization can be replaced by the reinforcement with plastic strips which will make the construction process economical and also make the proper arrangement of plastic waste conserving the various component of the environment.
Megnath Neopaney, Ugyen, Kezang Wangchuk, Sherub Tenzin **[5]** infered that base course thickness can be significantly reduced if waste plastic strip is

used as soil stabilizing agent for sub-grade material. They got the optimum result when 0.5% is added to it.
According to E.I. Atuanya, W.T. Aborisade and N.A. Nwogu**[6],** the result of the physico-chemical parameters of the soil revealed that the addition of plastic granules to the soil resulted to increase in the bulk density of the soil.
According to Muntohar, A. S**[7]** , the clay soil was stabilized with lime and rice husk ash mixtures. The effect of the fiber length and content on the compressive and split tensile strength was investigated.
Priti Mishra, Jha Ajachi R.B., Mohnish Satrawala, Harsh Amin**[8]**, analysed that the fiber inclusion changes the behavior of waste recycled product from brittle to ductile. The ratio of split tensile strength and unconfined compressive strength increases with increase in fiber content.

III. Methodology and Materials

The main purpose of the project was to evaluate the effect on the soil properties due to the addition of
plastic granules. Mainly the study was concentrated on the strength property. Waste plastic which is being converted into plastic granules was taken in different percentage by weight of the soil for the experimental studies.

3.1 SOIL
Locally available weak soil was used in this study having the following properties.

TABLE 1 Basic properties of soil

PROPERTY	VALUE
Specific gravity	2.5
Moisture content	23.2 %
Permeability	3.48 X 10^{-4} cm/s
Liquid limit	31.69 %
Dry density	1.45 g/cm^3
Coefficient of consolidation	0.370 mm^2/s
Compression index	0.17
D10, D30, D60	39µ , 85µ ,150.5µ

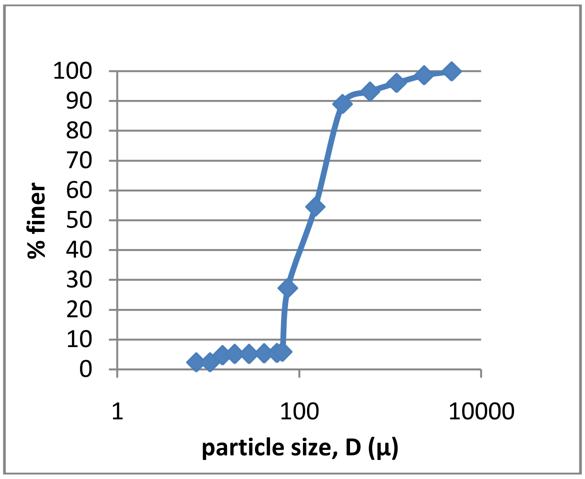

Fig 1. Grain size distribution
From the graph, we can say that %gravel=

3.2 PLASTIC
The waste plastic strips used in the present study were purchased from an industry, which converts the waste plastic cheaply into granules for the manufacturing of bottles etc. The plastic granules have specific gravity about 0.91 – 0.96. It has a dimension of 3mm x 2mm.

IV. Experimental Work

The basic properties of the clay were determined. The experiments are conducted by using soil without plastic and with plastic granules in varying percentage. The percentage of plastic were taken are 0.25%, 0.5% and 0.75%. The results were compared among themselves.

4.1 PROCTOR'S COMPACTION TEST
The optimum moisture content and the maximum dry density of the soil samples for various percentage of plastic granules (0%,0.25%,0.5%and 0.75%) were determined by performing the Standard Proctor's test. The dry density was determined and plotted against the corresponding water content to find the optimum moisture content and the corresponding maximum dry density. The values of OMC and MDD of various %of plastic granules are tabulated in Table 2

TABLE 2. Proctor's Test

% plastic granules added to soil	OMC (%)	Max dry density (g/cc)
0	17.9	1.68
0.25	13.9	1.8
0.5	19.2	1.64
0.75	16.5	1.66

EFFECT ON COMPACTION CHARACTERISTICS

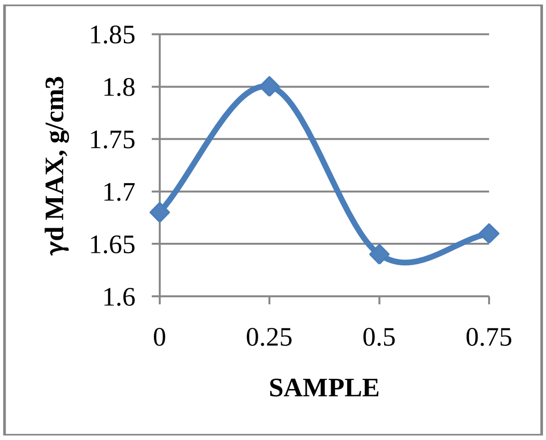

Fig 2 Max dry density Vs % plastic

Figure 2 shows that the maximum dry density obtained when 0.25% plastic was added into the soil. The MDD corresponding to 0.5% and 0.75% are slightly less than that of the soil without plastic

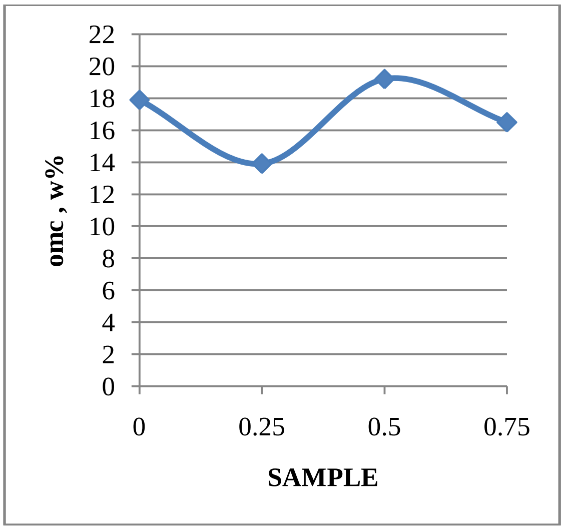

Fig 3 OMC Vs % plastic

The figure 3 shows the variation of optimum moisture content with % of plastic added. It shows that OMC corresponding to 0.25% is much less than that of the OMC for the soil without plastic.

4.2 CALIFORNIA BEARING RATIO TEST

California Bearing Ratio test is one of the most commonly used method to evaluate the strength of sub grade soil for the design of pavement thickness. The CBR value of the soil samples for various percentages of plastic granules were determined. From the load penetration curve, the CBR value corresponding to the 2.5 mm and 5mm penetration was determined. The CBR value corresponding to these penetrations for different percentage of plastic are shown in the table below.

TABLE 3. CBR value.

% of plastic granules	CBR for 2.5mm penetration	CBR for 5mm penetration
0	19.7	18.68
0.25	17.51	17.08
0.5	10.76	11.435
0.75	18.17	17.51

Figure 4 shows that, there is no considerable change in the CBR value for 0.25% plastic from soils without plastic. But there is a decrease in the CBR value for soil with 0.5% plastic.

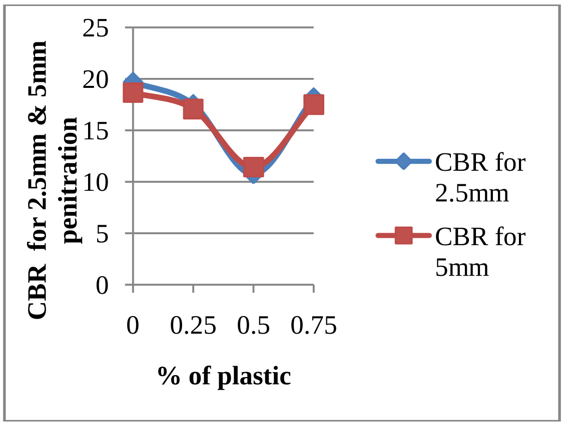

Fig 4 CBR value Vs % of plastic

4.3 DIRECT SHEAR TEST

The test was conducted on the soil sample with various percentage of plastic granules(0%,0.25%,0.5% and 0.75%). The values of cohesion and angles of internal friction for various percentage of plastic are tabulated in Table 4.

TABLE 4 Direct Shear test

% of plastic added	Cohesion (kg/cm^2)	Angle of internal friction (^{0})	Maximum shear stress(kg/cm^2)
0	0.1	21.61	0.439
0.25	0.05	21.03	0.515
0.5	0.03	28.07	0.456
0.75	0.02	22.44	0.413

The figure 5, 6 and 7 show the variation of Cohesion, angle of internal friction and Maximum shear stress for various percentage of plastic.

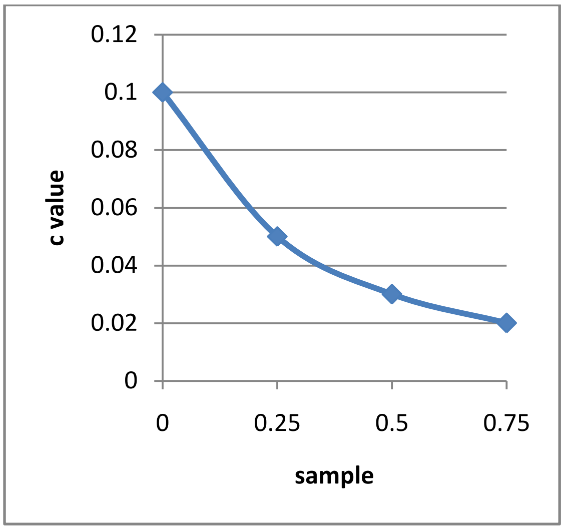

Fig 5 cohesion Vs % of plastic

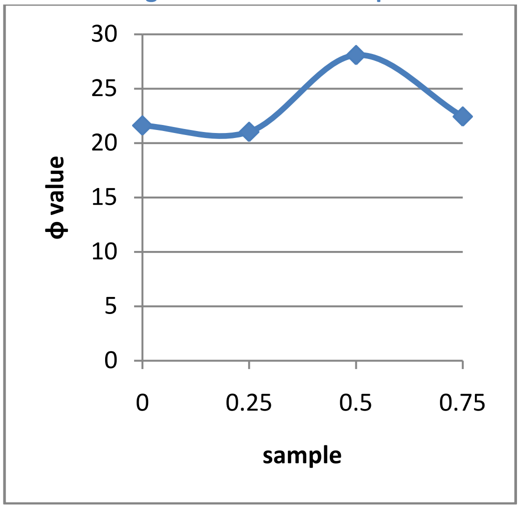

Fig 6 angle of internal friction Vs %of plastic

Figure shows that the maximum shear stress is for the soil with 0.25 % of plastic content.

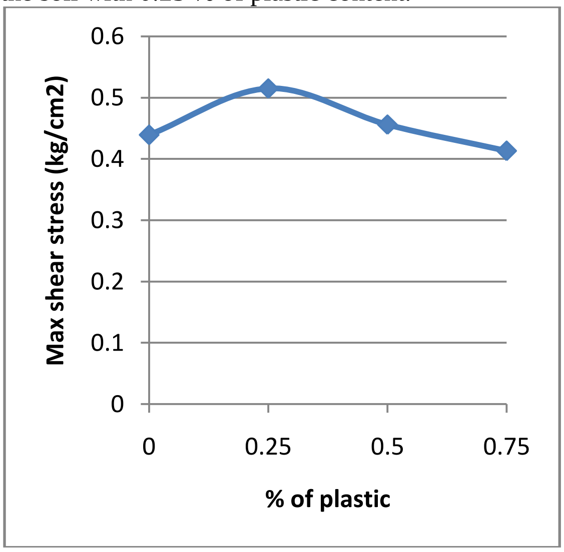

Fig 7 Max shear stress Vs % of plastic

4.4 PERMEABILITY TEST

The property of a soil, which permits the flow of water through it, is called permeability. In other words, permeability is the ease with which water can flow through it. In this test, the soil without plastic granules is a little permeable and soil with varying plastic is not at all permeable. During the test, water did not flow through the soil specimen containing varying percentage of plastic granules.

V. Conclusion

The effect of plastic granules on soil samples were studied by conducting tests with various percentages of plastic granules and the following conclusions were drawn.

- Max dry density is obtained when 0.25% plastic was added in to the soil and OMC corresponding to 0.25% is less than that of soil without plastic.
- CBR value decreased when 0.5% of plastic is added. It is increased when 0.75% of plastic is added.
- The shear stress is maximum when 0.25% of plastic is added.
- The plastic should be uniformly mixed with soil for an effective result.

Even though this method is not much effective in stabilization; it can be used as an effective method in disposing waste plastic materials.

Reference

[1] A.K. Choudhary, J.N. Jha and K.S. Gill, A Study On CBR Behavior Of Waste Plastic Strip Reinforced Soil, *Emirates Journal for Engineering Research*, 15 (1), 51-57 (2010).

[2] Prof. G L Sivakumar Babu, Laboratory shear strength studies of Soil admixed with Plastic waste, CiSTUP Indian Institute of Science.

[3] Mohammad M. Khabiri, The Influence of Waste Carpet on the Structural Soil Characteristics in Pavement Granular Layer, *The international journal published by the Thai Society of Higher Education Institutes on Environment*, 2011, 38 – 48.

[4] Pragyan Bhattarai, A. V. A Bharat Kumar, K. Santosh, T. C. Manikanta & K. Tejeswini, Engineering Behavior Of Soil Reinforced With Plastic Strips, *International Journal of Civil, Structural, Environmental and Infrastructure Engineering Research and Development* (IJCSEIERD) ISSN 2249-6866 Vol. 3, Issue 2, Jun 2013, 83-88

[5] Megnath Neopaney, Ugyen, Kezang Wangchuk, Sherub Tenzin, Stabilization of Soil by Using Plastic Wastes, *International Journal of Emerging trends in Engineering and Development, ISSN 2249-6149 Issue 2, Vol.2 (March-2012)*

[6] E.I. Atuanya, W.T. Aborisade and N.A. Nwogu, Impact of Plastic Enriched Composting on Soil Structure, Fertility and

Growth of Maize Plants, *European Journal of Applied Sciences* 4 (3): 105-109, 2012 ISSN 2079-2077.

[7] Muntohar, A. S, Influence of Plastic Waste Fibers on the Strength of Lime-Rice Husk Ash Stabilized Clay Soil, *Civil Engineering Dimension*, Vol. 11, No. 1, March 2009, 32-40 ISSN 1410-9530.

[8] Priti Mishra, Jha Ajachi R.B., Mohnish Satrawala, Harsh Amin, Experimental Study On Waste Recycled Product (W.R.P.) And Waste Plastic Strips (W.P.S.) As Pavement Sub-Base Material, *International Journal Of Scientific & Technology Research* ,Volume 2, Issue 12, December 2013 ISSN 2277-8616.