An Experimental Study on Partial Replacement of Soil with Plastic Granules

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Abstract— This paper studies 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 show increase in the strength of soil. Laboratory U.C.C tests were conducted on soils with and without plastic granules. Plastic granules were added in different percentage and the effect on soil behavior is studied. It is observed that there is considerable change in the behavior of soil due to the addition of plastic granules. The strength depends upon the percentage of plastic granules added.

Index Terms— Improvement of soil, Partial Replacement of soil, Plastic Granules, Plastic waste, soil reinforcement, Strength of soil, U.C.C Test.

1 Introduction

SOIL reinforcement is an effective and reliable technique for improving the strength and stability of soil. The soil reinforcement technique has wide applications in areas like construction of road, slope stabilization, railway embankments, and so on.

Several studies have been reported which relate to the reinforcement techniques in soil. Studies are conducted on reinforcement of soil using coir, geogrid, geomat, and geosynthetics.

Numerous papers have examined the reinforcement of soil with plastics. Amrutha T.P and Aswathy Krishnan (2015) studied on plastic waste as a soil stabilizing agent. According to their study CBR value increase with increase in percentage of plastic strips added. The addition of plastic strip increased the penetration resistance of soil and the unconfined compressive strength test shows that stress-strain behaviour was improved by the addition of plastic strip. It is observed that the void ratio and permeability of soil samples are decreased with the addition of plastic strips. Akshat Mehrotra et al (2014) analyzed the effect of high density polyethylene (HDPE) plastic on the unconfined compressive strength of black cotton soil. The study involves the determination of unconfined compressive strength. The study proved that the soil with plastic pieces have more strength than the plain soil. The strength improved with respect to the percentage of plastic present in the test specimen.

Pragyan bhattarai et al (2013) studied about the Engineering behaviour of soil reinforced with plastic strips. The indicate that the plastic strip reinforcement act as an efficient stabilizing agent. From this study it is clear that the plastic strip contained soil specimen have much strength as compared to the unreinforced soil specimen. The CBR value increases by the addition of plastic strip in the soil with different percentage. The study reveals that addition of plastic waste as a strip is cost effective method of soil stabilization.

G.L Sivakumar Babu (2012) had conducted Laboratory shear strength studies on a soil admixed with plastic waste. The study revealed that the UCC strength increases with the addition of plastic waste. From the CBR test it is concluded that CBR value increases with increase in the percentage of plastic bottle pieces. The piping test is also conducted using geogrid waste and the piping resistance can be improved significantly due to the addition of plastic waste with fly ash. The test showed that geogrid waste provides piping resistance more than that of plastic waste.

This paper pertains to the study of partial replacement of soil with plastic granules. Laboratory compaction tests and UCC tests were conducted on soil with and without plastic granules, considering several parameters. The effects of plastic granules on the engineering properties of soil are studied by varying the percentage of plastic granules.

2 Concept of Soil Replacement with Plastic Granules

The soil is partially replaced with plastic granules. The stiff plastic granules replace the loose soil, thereby improving the stiffness of soil which adds the strength of soil. Plastic granules are added in different percentage; say 0, 0.25 and 0.5%. The soil attains high engineering strength which can be thus used to engineering construction.

3 Material Properties

3.1 Soil

The soil used for the study is silty clay. The properties of the soil are given in Table 1.

3.2 Plastic Granules

Plastic granules used for the study is 2 mm in diameter and 3mm in length. It is light cream in colour.

4 Experimental Procedure

A series of standard procter tests and UCC tests were performed to investigate the influence of plastic granules on the

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engineering properties of soil. The testes were performed on soil with without Plastic granules. The percentage of the Plastic granules added varied from 0, 0.25 and 0.5% of soil.

TABLE 1
PHYSICAL PROPERTIES OF SOIL

Properties	Value
Specific Gravity	2.615
Liquid Limit (%)	84
Plastic Limit (%)	35.06
Plasticity Index	48.94
Dry density (g/cm³)	31.2
Optimum moisture content (%)	1.382

5 TEST RESULTS AND DISCUSSIONS

5.1 Compaction Behaviour

A series of standard procter test were conducted on soil reinforced with varying percentage of plastic granules. It is observed that the dry density of the soil increases with increase in percentage of plastic granules. The maximum density is obtained for soil with 0.5% plastic granules. The corresponding optimum moisture content is observed to be decreasing with increase in percentage of plastic granules. The dry density vs water content behavior corresponding to soil with different percentage of plastic granules are presented in Fig 1.

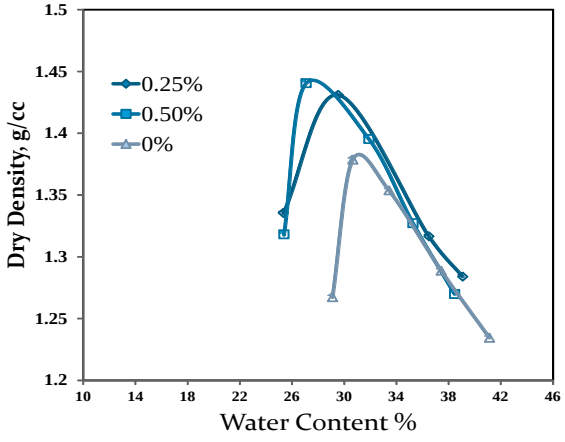

Fig. 1. The dry density vs water content behavior corresponding to soil with different percentage of plastic granules.

5.2 Strength Behaviour

UCC tests were conducted to investigate the strength behaviour of soil with plastic granules. It is observed that the strength increases with increase in plastic granules. The soil is partially replaced with plastic granules which is stronger than soil. The Load vs Deflection behavior of soil with different percentage of plastic granules is shown in Fig 2.

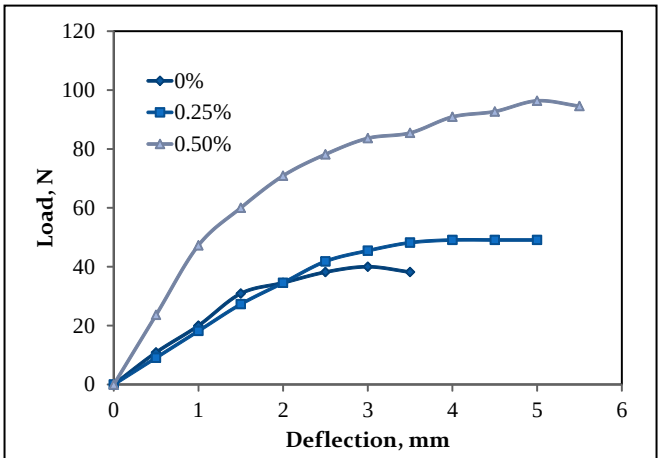

Fig. 1. The Load vs Deflection behavior of soil with different percentage of plastic granules.

5.3 Strength Behaviour

The strength improvement due to the replacement of plastic granules is represented using a non-dimensional parameter, called the strength improvement ratio (SIR) which is defined as the ratio b tween the Load taken by reinforced soil to that of the unreinforced soil for the same deflection. The strength improvement ratio (SIR) for different configuration of soil are shown in Table 2

It is observed that the strength improvement ratio (SIR) increases with increase in percentage of plastic granules. It shows the improvement of strength of soil with replacement of plastic granules.

TABLE 2
SIR VALUE FOR DIFFERENT CONFIGURATIONS

Percentage of Plastic Granules	SIR Value
0	1
0.25	1.13
0.50	2.09

6 CONCLUSION

In this paper a different mode of soil reinforcement with plastic granules is proposed. A set of standard procter tests and UCC tests were performed to investigate the behavior of soil reinforced with different percentage of plastic granules. The following conclusions are drawn from the study:

- The density of the soil composite increases with increase in percentage of plastic granules.
- The optimum moisture content reduces with plastic granules
- The strength behavior shows a great influence on the percentage of plastic granules.
- Load –deflection behavior of soil found to be improving with plastic granules.

- The reinforcement of soil with plastic granules solves the problem of plastic disposal along with improvement in engineering properties of soil. It propose a healthy waste disposal method

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