

A Review Literature on the Use of Waste Plastic to Improve Geotechnical Properties of Soil

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Abstract - Soil stabilization alters the physical properties of soil in order to improve its strength, durability, or other qualities to meet the engineering requirements. It can be achieved by adding suitable admixtures like cement, lime and waste material like fly ash, gypsum etc or by other suitable stabilization method. the cost of adding these additives has tremendously increased in past few years; there for there is need for the development of other kinds of soil additive such as plastic, bamboo etc and these new techniques of soil stabilization using plastic waste which can be effectively used to solve the challenges of society, thereby reducing the amount of waste plastic material. Use of polythene bags, bottles, and other plastic products is exponentially increasing year by year due to which we are facing various environmental problems. Therefore the correct way disposing off of the plastic waste without causing any ecological hazard has become a real challenge today. A review paper is presented here to focus on soil stabilization methods by using waste plastic products.

Key Words: Soil Stabilization, Polythene, Fibre reinforced material, Soil strength, Re-use and Recycling, Ground improvement, Engineering properties, Economical.

1. INTRODUCTION

The Properties of a soil are very uncertain when it is subjected to variable moisture. It shows huge volumetric change when exposed to dry and wet conditions. This is due to presence of active clay mineral. When water occupies large space in the voids of soil the strength of soil changes. These changes create challenges for civil engineers doing work on site specially while constructing foundations. Though black cotton soil is unfit for infrastructural development, they are useful to protect environment and waste disposal. For the construction of any kind of structure resting on weak soil, various available methods are used to improve the bearing capacity and reduce the settlement of soils. One of the methods is using reinforcement. The concept reinforcement of soil by using fibres was developed in the 19th century. The main objective of reinforcing the soil was to upgrade its properties. The reinforcing material introduced in the soils alters the strength and deformation characteristics of the soil. Plastic is considered as one of the

best invention in many aspects of life. The amount of plastic waste is increasing year by year. Due to this the need of plastic waste management has increased so that it can be used as soil stabilizer and in other ground improvement techniques as it behaves like reinforcing material. Hence to make the development path sustainable the use of plastic waste in geotechnical engineering needs to be encouraged. By doing so, Properties of soil will be improved and reuse of plastic can also be made efficiently.

1.1 Data on Generation of Plastic waste and Plastic Consumption:

The consumption of Plastic in India is about to reach 200 lakh tonnes by the year 2020 due to growing use of different forms of the commodity. In 2013 About 120 lakh tonnes were the consumption of plastic in India. The consumption of plastic in different forms is increasing by an average of 10% every year. Rate of generation of waste in Indian cities ranges between 0.20-0.87 Kg/day, depending upon the region's living standard and the size of the city. About 1.3% per capita per year waste generation is increasing by about 1.3 % in India. Every year about 8 million tons of plastic is dumped into the world's oceans.

1.2 Plastic waste classification

Plastics waste is of two types:

- Pre-use plastic (production scrap)
- Post-use plastic

Pre-use plastic

That plastic which does not fulfil the desired requirement during casting and assembly i.e. material that has the mismatching colour, undesirable hardness, or wrong processing characteristics are called Pre-use plastic waste. This material is easy to use for other applications and has the property to get recycled. Pre-use plastic waste is the ultimate source of plastics which are suitable for reprocessing from manufacturers of plastic products. Processing of Pre-used plastic is less as compared to post-use hence Pre-use is more valuable than Post-use plastic.

Post-use plastic

Post-use plastic waste suitable for recycling generally falls into one of five main categories:

- Plastic bottles, pots, tubs and trays
- Plastic film
- Rigid plastics, such as crates, pipes and mouldings
- Plastic foams, such as expanded polystyrene (EPS)

Flexible plastics, such as strapping and cable sheathing

2. LITERATURE REVIEWS

Mercy Joseph Poweth et al in 2013 investigated on safe and productive disposal of quarry dust, tyre waste and wastes-plastic by using them in the pavements sub grade. In their paper a series of CBR and SPT test were carried out for finding the optimum percentages of waste plastics, and quarry dust in soil sample. The results shows only quarry dust should be mixed with the soil plastic mix, to increase its maximum dry density and is suitable for pavement sub grade. Tyres alone are not suitable for sub grade. They concluded that Soil plastic mixed with quarry dust maintains the CBR value within the required limit. Soil tyre mixed with quarry dust gives lesser CBR value than soil plastic quarry dust mix but it can be used for pavement sub grade.

Dr. A.I. Dhattrak et al in 2015 after reviewing performance of plastic waste mixed soil as a geotechnical material, it was observed that for construction of flexible pavement to improve the sub grade soil of pavement using waste plastic bottles chips is an alternative method. In his paper a series of experiments are done on soil mixed with different percentage of plastic (0.5%, 1%, 1.5%, 2 % & 2.5%) to calculate CBR. on the basis of experiments that he concluded using plastic waste strips will improve the soil strength and can be used as sub grade . It is economical and eco-friendly method to dispose waste plastic because there is scarcity of good quality soil for embankments and fills.

Akshat Malhotra and Hadi Ghasemain et al in 2014 studied the effect of HDPE plastic waste on the UCS of soil. In a proportion of 1.5%, 3%, 4.5% and 6% of the weight of dry soil, HDPE plastic (40 micron) waste was added. They concluded that the UCS of black cotton soil increased on addition of plastic waste. When 4.5 % plastic waste mixed with soil strength obtained was 287.32KN/m² which is maximum because for natural soil it was 71.35KN/m².

Choudhary, Jha and Gill et al in 2010 demonstrated the potential of HDPE to convert as soil reinforcement by improving engineering properties of sub grade soil. From waste plastic HDPE strips are obtained and mixed randomly with the soil and by varying percentage of HDPE strips length and proportions a series of CBR tests were carried out on reinforced soil. There results of CBR tests proves that inclusion of strip cut from reclaimed HDPE is useful as soil reinforcement in highway application.

Rajkumar Nagle et al in 2014 performed CBR studies for improving engineering performance of sub grade soil. They mixed Polyethylene, Bottles, Food packaging and shopping bags etc as reinforcement with black cotton soil, yellow soil and sandy soil. Their study showed that MDD and CBR value increases with increase in plastic waste. Load bearing capacity and settlement characteristics of selected soil material are also improved.

Achmad Fauzi et al in 2016 calculated the engineering properties by mixing waste plastic High Density Polyethylene (HDPE) and waste crushed glass as reinforcement for sub grade improvement. The chemical element was investigated by Integrated Electron Microscope and Energy-Dispersive X-Ray Spectroscopy (SEM-EDS). The engineering properties PI, C, OMC values were decreased and ϕ , MDD, CBR values were increased when content of waste HDPE and Glass were increased.

Cebet et al in 2014 did laboratory investigations to determine the increase in shear strength and bearing capacity of locally available sand due to random mixing of strips of HDPE (high density polyethylene) material from plastic shopping bags. A visual inspection of the plastic material after tests and analysis indicates that the increased strength for the reinforced soil is due to tensile stresses mobilised in the reinforcements. The factors identified to have an influence on the efficiency of reinforcement material were the plastic properties (concentration, length, width of the strips) and the soil properties (gradation, particle size, shape)

Hatem Nsaif et al in 2013 concluded by mixing plastic waste pieces with two types of soil (clayey soil and sandy soil) at different mixing ratios (0,2,4,6,8)% by weight respectively that, there is significant improvement in the strength of soils because of increase in internal friction. The percentage of increase in the angle of internal friction for sandy soil is slightly more than that in clayey soil, but there is no significant increase in cohesion for the two types of soils. Also, it was concluded that due to low specific gravity of plastic pieces there is decreases in MDD and OMC of the soil.

3. CONCLUSIONS

Following conclusions are drawn based on the studied conducted by various researchers.

- 1) Annually, a lot of waste rubber and Plastic are generated and occupied a great space. It is necessary to find a solution to solve this problem. Based on literature, one of the solutions is use of different size waste rubber and plastic in soil reinforcement. ⁽¹⁾
- 2) Reinforcing sand with waste HDPE strips enhances its resistance to deformation and its strength. However further study is needed to optimize the size and shape of strips and to assess the durability and aging of the strip. Large scale test is also needed to determine the boundary effects influence on test results. ⁽³⁾

3) Various models are proposed to predict shear strength parameters. Additional experimental results are needed to validate these proposed design models and further modifications are required. Available models are limited in scope involving some parameters either difficult to estimate or some value is suggested applicable to particular soil fibre studied. Yet, no complete model is available to account for all parameters affecting strength of Randomly Distributed Fibre Soil (RDFS).

4) Utilization of waste HDPE and Glass were eliminates need for expensive borrow material and promotes cost saving through decreasing of pavement thickness, solving disposal problems. (6)

5) Results by various researchers give positive indication to the possibility of using the versatile plastic bag material for soil reinforcement. Successful application could help to reduce the amount of plastic waste which is disposed off to landfills and contribute to sustainable development by providing low-cost material to the resource intensive geotechnical industry. (7)

6) The variation of the friction angle of clayey soil with percentage of plastic content is a nonlinear variation and similar trend is found in sandy soil. (8)

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