Soil Stabilization Using Plastic Waste Materials – A Review

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Abstract- *The process which enhances the engineering properties such as shear strength, bearing capacity, etc of soil is referred as soil stabilization. As almost every structure needs a strong foundation on which it can withstand strongly. Soils like black cotton soil always deals with the problem of shrinkage, swelling and unequal settlement. Today, disposing of Waste plastic materials are one of the major problems faced by the world. The use of plastic waste materials for stabilization of soil and using plastic as soil stabilizer reduces the problem of disposing plastic waste material to a certain extent and also helps to overcome environmental problems. Aim of this study is to figure out the ways to make utilization of plastic waste materials in civil engineering applications on a big scale. Stabilization of soil has been done with the use of unproportionate waste plastic materials to improve properties like shear strength parameters, compaction effect and bearing strength of black cotton soil.*

Keywords- Soil stabilization, California Bearing Ratio, Unconfined Compressive strength, Expansive soil, Plastic waste.

I. INTRODUCTION

In the past few decades due to rise in population, a growth in the plastic industry is observed. The recycling of plastic is expensive and complicated. The decomposition of plastic waste is not possible as it is not liable to decay. The disposal of enormous amount of plastic is difficult. Various researchers try to use the plastic waste in the field of soil stabilization. One of the prominent uses of plastic waste is stabilization of soil. In India most of the soil is expensive and cohesionless in nature which possess low engineering properties. Stabilization enhances the properties of expensive soil and made them suitable for pavement construction.

Use of various compaction technique as suitable substances like cement, and waste material like PET, PP, PS, HDPE etc., can bring out the soil stabilization. It is observed that CBR test, modified proctor test, sieve analysis, plastic limits tests are conducted to check the necessity of waste material as soil enhancer. Modified proctor test depicts the optimum moisture content (OMC) and dry density of sample. California bearing ratio test gives the optimum plastic content. the amount of plastic percentage added to the soil sample above which the CBR value falls is known as optimum plastic content. Modified proctor test is preferred over standard proctor test as the soil used for subgrade construction requires high compaction. the use of plastic waste to the soil reduces the disposal problems of environment as well.

II. LITERATURE REVIEW

(Mercy Joseph Poweth, 2013) This study involves disposal of dust, non-biodegradable waste and plastic waste by using them in the pavement's subgrade. To study the sample, a number of CBR and SPT test were performed for figure out the optimum percentage of plastic in sample. The outcome depicts only dust enhances the maximum dry density which is useful for pavement subgrade. Only non- biodegradable materials are not suitable for pavement subgrade. From this experimental study it has been stated that dust mixed with plastic maintains the California Bearing Ratio value in the optimum limit.

(Subhash,2016) The author conducted experimental activity on stabilization of soil by using plastic and glass with unproportionate mixture. The various tests such as Modified Proctor Tests were experimented to study OMC and CBR. The study provides that there is a decrease in the level of Maximum Dry Density (MDD) on increasing the amount of glass and plastic. Around 6% amount of plastic and glass, the Maximum dry density of 1.51 gm/cc observed. Maximum OMC was observed at 22.4% at 5.9% mixing of admixture. Moreover, an increase in the level of OMC was observed, maximum value attains at 22.5%. Increase in the unconfined compressive strength 0.610 kg/cm^2 to 3.022 kg/cm^2 which is about 4.5 times as of soil sample. The Maximum CBR value observed at 7.15% i.e., two times of CBR of initial soil sample.

(Mallikarjuna, 2016) Author experimented research work on black cotton soil stabilization using plastic waste. Author mainly accommodates the experiments to overcome the problems in Amaravathi (the capital of Andra Pradesh, India). Various contents of strips of plastic weight percentage ranges from 0.0% to 8.5% are mixed with soil sample of black cotton

soil and optimum percentage of plastic waste strips was analysed by experimenting CBR Test. Sample collected from used chairs of plastic and are cut in to different strips. Density of strips of plastic of 0.40 gm/cc mix with black cotton soil in varying percentages of 1%, 3%, 5% and 7%. In this study a series of CBR test and modified proctor test has performed on the soil sample. The author stated that the value of CBR increases up to 5% content of plastic.

(Prof. Harish, 2016) the research work includes the plastic waste materials in the form of strips. The mixing of strips of bottles in the soil sample by manipulating percentages and performing tests like Compaction Tests, CBR Tests, Plastic Limit Tests, Liquid Limit Tests etc., has proved out to be very effective. Bearing capacity of the soil increases drastically and engineering properties like shear strength improves within a specific limit of compaction.

Table 1 (CBR Values of Red Soil)

Content of plastic (%age)	CBR Values
0.0	2.3
0.2	2.0
0.4	2.1
0.6	2.4
0.7	2.9
0.8	1.8
1.0	1.7

Table 2 (CBR value of Black Cotton Soil)

Content of plastic (%age)	CBR Values
0.0	2.7
0.2	2.5
0.4	2.6
0.5	3.3
0.6	2.1
0.8	2.1

The study includes use of both red soil and black cotton soil which involves – 5% Gravel, 86% sand and 9% (silt and clay). After experimenting, it was observed that soil sample gives maximum dry unit weight of 19.12 KN/m^3 and 21.03 KN/m^3.optimum moisture content (OMC) of 13% and 10% found out modified proctor test. The sample of Black cotton soil consists 2.5% gravel, 15% sand, 82.4% silt and 0.19% clay. From this study, it is stated that maximum dry unit weight 16.56 KN/m^3 and 17.33KN/m^3 with an optimum moisture content of 13.52% and 10.21%.

(Ilies, N.M.,2017) This study paper involves two ways to enhance soil properties. The first way was to enhance soil mixing with plastic garbage. Another method to improve with cement. Source of waste plastic used in this experimental study involves Polyethene Plastic Waste. The research examine shear strength parameters changes when different amount like 2%, 4%, 6% and 8% of cement or Polyethene are added. The study was performed on a silty clay. Mixing the soil with 4% of Polyethene, various manipulations were observed. 4% Polyethene soil mixture compared with same amount of cement soil mixture, the Polyethene mixture consists of less cohesiveness of around 51% and less internal friction angle of around 62%. At the end, though the performance of soil cement sample was greater but due to some ecological point of observation polyethene had more advantage.

(Kiran, 2017) Aim of a stabilization technique involves the increment in the bearing capacity and stiffness of soil. The soil must be of workable in nature and constructable as well. In this experimental study, author used shopping bag strips and plastic bottle strips to improve the various engineering properties of soil. From this study it is been formulated that there is increment in CBR values of soil and CBR maximum is observed when 0.74% of plastic bottle strips are mixed with soil sample. On further increase in the amount of the strips, the CBR value decreases. The second case involves plastic bag strips, it stated that around 2% of the whole weight of the soil is represented as optimum amount of the strips. The author concluded that plastic bottles strips are better in comparison to the strips of soil bags as they enhance the CBR value of the soil sample.

(N. Vijay Kumar, 2017) This experimental research paper consists with observation of waste of plastic material as a soil stabilizer mostly of black cotton soil. Drawbacks that observed in this soil were swelling in contact of moisture, shrinkage and unequal settlement throughout the surface. This review paper focuses on soil stabilization for which various engineering experimental tests are performed such as liquid limit test, plastic limit test, standard proctor test, California bearing ratio test and Unconfined Compressive Strength to check the manipulations in engineering properties of soil. The research paper involves use of plastic and bottle strips materials in enhancing bearing capacity of soil sample. Table 3 shows the CBR value in comparison of the length of plastic strip.

CBR Value	Length of strips (cm)
3.33	0
5.22	2.4
6.21	5.1
5.22	7.4

For the different values of lengths like 2.4 cm, 5.1 cm, and 7.4 cm, between 2.5 cm to 5 cm has CBR value 5.22 to 6.21 appropriately increases and between 5 cm to 7.5 cm length has CBR Values decreases from 6.21 to 5.22. At last, it has been formulated from the results that the shear strength of soil sample increases up to 5.0cm length and afterwards decrement and vice-versa. The values of CBR for 5.1 cm is 6.21 which stated as optimum length of plastic strip for subgrade preparation.

(Peddaiah, 2018) this study involves the role of plastic bottles on sand which is silty in nature, for which a number of various tests like compaction test, direct shear test and California Bearing Ratio test have been experimented on it. Study have been performed out by mixing plastic materials in the percentage of 0.20%, 0.40%, 0.60% and 0.80% and length of plastic waste strips (15.0 mm x 15.0 mm) (15.0 mm x 25.0 mm) (15.0 mm x 35.0 mm). With increase in amount of plastic content, properties like maximum dry unit weight and shear strength parameters also increases. In this study, it is observed that the values of CBR for the soil sample ranges from 3.2 to 7.2 for respective of 0.20% plastic and 3.2 to 16.4 for 0.40% plastic content. Enhancing in engineering properties of sand which is silty in nature are observed in this study when plastic content is 0.4% and the size of the plastic strips 15.0 mm x 15.0 mm. At last, from this study, it is concluded that the plastic waste strips can be used in construction of subgrades and structural utility.

(Tarun Kumar, 2018) stated that use of various size of strips made from the plastic materials can be used as an alternate way for the stabilization of soil. To study the stabilization caused by the effect of various mixed plastic strips, various tests such as modified proctor tests and unsoaked California bearing ratio tests are performed and it is formulated that MDD of plastic mixed soil sample decreases with increase in content of plastic waste strips. for CBR, it increases with increase of percentage of plastic waste strips within a optimum range. Based on research, MDD values decreases while the values of Optimum Moisture Content increases. It is observed that there is also increase in the level of CBR values of soil sample with increase the percentage of plastic strip made up of plastic waste materials.

It is concluded that the maximum CBR value obtained when content of waste plastic strips is 0.81% of dry weight of soil sample. Finally, 0.81% of plastic strips of dimension of 2 cm is considered as optimum amount.

(Abdelsalam, 2019) experimented the use of High-Density Polyethylene (HDPE) slightly mixed with cohesionless soil. Author experimented various tests such as Direct Shear Test, one- dimensional consolidation test, etc. To figure out the shear strength values and consolidation engineering properties of the soil sample. The content of HDPE added in the increment of 0.0%, 5.0%, 10.0% and 15.0%. The cohesion values and the angle of internal friction values ranges from 25 kPa and 36^o to 44 kPa and 45^o respectively. The content of HDPE fluctuated from 0 to 15%. The coefficient of permeability and compressibility of sample of soil increases by mixing 5.0% HDPE slightly.

III. CONCLUSION

From the various studies it has been formulated that the inertness of plastic materials such as HDPE, PE, LDPE, are useful in all weather conditions. Since they are non-biodegradable in nature and cost effective, they are the most favourable choice for stabilization of soil. The addition of various plastic materials, it has been observed that the engineering properties of the soil makes it suitable for construction. It is observed that values of shear strength and the California Bearing Ratio (CBR) tests increases while maintaining the strip length. Finally, plastic materials of various properties can be used as a soil stabilizer for pavement subgrade.

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