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To Enhance Soil Stabilization by Using Plastic Waste

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***Abstract*: Soil stabilization could be a method of improvement of the physical and Engineering properties of soil, like increasing bearing capability, shear strength, etc. which may be utilized by dominant compaction or addition of appropriate blends like cement, lime and waste materials like ash, waste Plastics & bottles etc. Recently, the utilization of plastic product, like polythene (PE) bottles and polypropylene (PP), has been considerably increased, which can cause several environmental problems. Therefore, it's vital to seek out strategies to manage these waste materials while not inflicting any ecological hazards. We use these strategies is to use plastic wastes as a soil stabilizing material. We think that this new technique of soil stabilization may be effectively want to meet the challenges of society, to cut back the quantities of waste, manufacturing helpful material from non-useful waste materials. The impact of the stabilization was evaluated through polishing off normal laboratory tests. In our project we perform soil tests like water content, Liquid limit test, plastic limit test, specific gravity of soil & Triaxial shear test etc. Plastic like searching luggage is employed to as reinforcement to perform the CBR studies whereas commixture with soil for rising engineering performance of sub grade soil. Plastic strips obtained from waste plastic were mixed indiscriminately with the soil. We performed UU- triaxial test on soil at different percentages and get various conclusions accordingly, test was allotted on indiscriminately strengthened soil by varied proportion of plastic strips at varied percentages of plastic in proportions.**

***Keywords*: Plastic bottles, CBR, Compaction, Triaxial shear test.**

1. Introduction

Stabilization is the technique of improvement of soil capacity and some methods applied for modifying the properties of soil for engineering performance. Soil stabilization techniques always prefer to increase the soil capacity. Some material such as cement, lime and fly ash are main component of soil stabilization techniques. Methods of soil stabilization may be grouped under two main types: (a) Modification of soil properties of existing of admixture, and (b) Modification of properties occur at fix proportion stabilization materials. The soil stabilization technique is the system of improve the bearing limit of soil utilization of controlled compaction, proportioning additionally the option of reasonable admixture or stabilizer is used as soil adjustment or "The strategy for improving the building properties of soil by embracing different adjustment procedure is named as soil adjustment". In these techniques of soil stabilization, the soil is treated in such manner so as to improve its physical conditions or properties to make it more stable and durable. Soil stabilization becomes necessary when a highway and any type of structure are required to be built over weak soil or poor bearing capacity. It is a necessary part of increase the durability and stability of the structure and building. Soil stabilization is segregating some impurities from the soil; we get good outcomes for our construction work. So, it is very good technique to makes strong compressive strength, bearing capacity to protect soil from failure. Therefore, in present study stabilization of soil is reviewed by using locally available plastic waste products of plastic bottles are used in stabilization of soil in the form of strips of suitable dimensions. The objective of this study was improving properties of soil in economical way and reducing environmental pollution, and minimizes the problems of plastic waste disposal.

A. Methods of Soil Stabilizations

1. Mechanical Methodology of Stabilization: During this procedure, soils of various gradations area unit mixed along to get the specified property within the soil. This could 2 be done at the location or at another place from wherever it is often transported simply. The ultimate mixture is then compacted by the same old strategies to urge the desired density.

2. Additive Methodology of Stabilization: It refers to the addition of factory-made merchandise into the soil, which in correct quantities enhances the standard of the soil. Materials like cement, lime, bitumen, ash etc. area unit used as chemical additives. Generally, totally different fibers are used as reinforcements within the soil. The addition of those fibers manifest itself by 2 methods -

a) Orienting fiber reinforcement: The fibers area unit organized in some order and every one the fibers area unit placed within the same orientation. The fibers area unit ordered layer by layer during this sort of orientation.

b) Random fiber reinforcement: This arrangement has separate fibers distributed haphazardly within the soil mass. The blending is finished till the soil and also the reinforcement kind a lot of or less uniform mixture. Materials utilized in this kind of reinforcements area unit typically derived from paper, nylon, metals or alternative materials having varied physical properties.

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2. Literature Review

i) Tarun Kumar (et. al) (2018)

This study is carried out on the development of the roadways which is very important and required to be strong enough to support different loads. To meet these challenges plastic wastes are used in the forms of strips of various sizes for identifying the required percentage amount of plastic strips and providing the alternative way for disposing the plastic wastes. To study this reinforcing effect of mixed plastic strips in soil, a series of standard proctor and unsoaked CBR tests have been conducted and based on this it is observed that the maximum dry density of plastic mix soil decreases with increase of percentage of plastic strips, and for CBR increases with increase of percentage of plastic strips within a certain limit. Based on this conclusion should be drawn is that by increasing the amount of plastic contents, the value of the MDD decreases whereas the value of OMC increases. There is increase in CBR value for soil with increasing the percentage of plastic strips. The maximum CBR value is obtained when the percentage of the plastic strips is 0.8% of dry weight of soil. Hence 0.8% of strips having length of 2cm is considered as required amount.

ii) Sayli D. Madhavi (et. al) (2017)

This study reviews the experimental program conducted for stabilization of black cotton soil in the Amravati, a Capital of newly formed Andhra Pradesh state. They performed series of CBR testings to find out optimum amount of plastic content is required for obtaining maximum CBR value. It can be concluded that CBR percentage goes on increasing up to 4% plastic content in the soil and there on it decreases with increasing the plastic content. For the construction of any civil engineering structure the foundation is very important as it supports the structure and to achieve this strength stabilization of soil is required. Soil stabilization is done by addition of suitable admixtures like cement, lime, sand, fly ash. It is required to incorporate the new techniques of soil stabilization which can be effectively used to meet the challenges of society, to reduce the quantities of the waste and producing useful material from the non-useful material which cannot easily recycled.

iii) Sharan Veer Singh (et. al) (2017)

This paper focus on the soil stabilization by using plastic waste products. The plastic inclusion can improve the strength thus increasing the soil bearing capacity of the soil. Uses of plastic waste as reinforcement which reduces the disposal problem of the waste materials. Infrastructure is a major sector that propels overall development of Indian economy. For any Structure foundation has the prime importance, the strong foundation plays very important role. An expansive soil such as black cotton soil creates problems in foundation and for this stabilization of soil is required.

iv) Kiran Kumar Patil (et. al) 2017

Stabilization of soils is an effective method for improving the properties of soil. The main objective of any stabilization technique used for increasing the strength and stiffness of soil, workability and constructability of the soil. Plastic such as shopping bags is used for reinforcing the soil for improving the various properties of soil. Applications of stabilizing of soil are increasing the shear strength of soil, bearing capacity of foundations and for improving the natural soil subgrade for construction of highways and airfields. In this they are used plastic bottle strips and plastic bag strips for stabilization. From this study conclusion made is there is increase in CBR value of a soil and maximum CBR is achieved when 0.75% amount of plastic bottle strips are added to the soil after further addition of the strips there is decrease in the CBR value. In case of plastic bag strips, it has been observed that 2% of the total weigh of the soil is the optimum proportion of the strips, we can also state from this study that strips cut out of plastic bottles are better option than strips of soil bags, to increase the CBR value of the soil.

v) A. K. Choudhary (et. al) (2010)

Attempts have been made in this study to demonstrate the potential of reclaimed HDPE as soil reinforcement for improving engineering properties of the sub grade soil. Strips obtained from waste plastic with various dimensions were mix randomly with soil and find out appropriate amount of HDPE strips. They performed tests and interpreted the data based on the ratio of length to width of the strip.

3. Methodology

Site Selection:

- The soil was collected from Mawai, Banda (U.P).
- We have selected this site because it has highly sensitive Black-cotton soil.
- The soil present at this site has very poor shear strength and has highly shrinkage and swelling properties.

Why We Choose Black-cotton soil?

- We choose black-cotton soil because it consist high amount of montmorillonite clay minerals, which have highly shrinkage and swelling characteristics.
- Because of this high swelling and shrinkage nature, the structures constructed on these soils are experience cracks.
- This property of soil can also make foundation unstable and weak.
- Hence, there is a need for improving black-cotton soil to suite as foundation material.

Materials Used:

1. Black-cotton Soil: Soil collected from Mawai, Banda (U.P)

Fig. 1. Black-cotton soil

2. Waste Plastics: The waste plastic was collected from nearby disposal sites.

Fig. 2. Waste plastics

Laboratory Tests:

In this project there are various tests are required to perform in laboratory. These Tests are as-

1. Water Content Test.
2. Liquid Limit Test.
3. Plastic Limit Test.
4. Specific Gravity Test.
5. Triaxial Shear Test.

Determination of Water Content test

Weight of Clean non-corrosive empty container W1 = 15gm.

A small quantity of wet soil sample placed in container and weighed W2 = 58gm.

The weight of dry soil with container W3 = 53gm.

Now, we know that water content i.e.,

w = Ww/Ws = (W2-W3) / (W3-W1) w = (58-53)/(53-15)

w = 13.15%.

Determination of Liquid Limit:

It is defined as minimum water content at which soil has tendency to flow. At liquid limit, soil passes from plastic stage of consistency to liquid stage of consistency and vice-versa. All soils at liquid limit pose some negligible shear strength of 2.7 kN/m^2. Soil having higher value of liquid limit passes high compressive volume change is also more.

From the graph we obtained the liquid limit (WL) corresponding to 25 number of blows i.e., WL = 58%.

Determination of Plastic Limit:

It is defined as minimum water content at which soil is in plastic stage of consistency or behaves as plastic material. At plastic limit, soil passes from plastic stage of consistency to semi – solid stage of consistency and vice-versa. For determination of plastic limit is defined as minimum water content at which soil become crumple or crack when rolled in to 3mm diameter threat. In our project the plastic limit of black cotton soil is 35%.

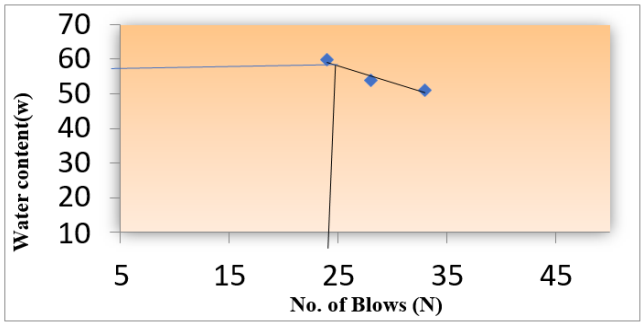

Fig. 3. Flow curve

Determination of Specific Gravity:

Specific gravity is the ratio of unit weight of dry soil solids to unit weight of water. It can be computed by using 50ml flask or by Pycnometer. Unit of specific gravity is kN/m^3. In our project Specific gravity of soil is 2.66.

Determination of Shear Strength Parameter by UU triaxial test:

UU Test: In our project we used triaxial unconfined undrain test i.e., UU test because it is suitable for saturated clay with short term analysis under undrain condition at fast loading rate. UU-test is also suitable for construction of building, road over saturated clays. This test takes only 5 to 7 minutes instantaneous expulsion of pore water is not permitted in both stages. A cylindrical soil specimen is subjected to three compressive stresses in mutually perpendicular directions and one of these three stresses being increased until specimen fails in shear. Initially, a confining pressure (σ3) is applied through water around the specimen in an impermeable membrane. The vertical stress becomes major principal stress (σ1) while the confining pressure σ3 acts in other two principal directions. The intermediate principal and minor principal stresses are equal to each other.

4. Results and Discussion

In our project various tests are conducted on soil sample like- Water content, liquid limit, Plastic limit, Specific Gravity Triaxial shear test. The test result values are as,

Table 1
Test results

Sr. No.	Tests on soil sample	Results
1.	Water Content Test	13.15%.
2.	Liquid Limit Test	58%
3.	Plastic Limit Test	35%
4.	Specific Gravity Test	2.67

Table 2
UU- triaxial test results

S. No.	Sample Specification	Cohesion (C)	Friction angle (Ø)	% Increase in shear strength
1.	Sample without Plastic	0.80	5.10	---------
2.	Sample with 1% waste Plastic	0.85	5.30	6.52%
3.	Sample With 2% waste Plastic	0.91	5.80	15.18%
4.	Sample With 3% waste Plastic	1.03	50	25.38%

After the investigation of UU-triaxial test we get the results as shown in table 2.

5. Conclusion

- From the results obtained by experimental study it was observed that addition of waste plastic increases the value of cohesion (C) and also increases the friction angle & hence, shear strength also increased.
- But if we added maximum amount of plastics then MDD and internal friction angle reduced.
- With the addition of 1% of plastic cohesion increased by 6.20%, friction angle increased by 4% & shear strength increased by 6.52%.
- With the addition of 3% plastics cohesion in increased by 28.75% & shear strength increased by 25.38%.
- Shear strength parameters can be determined by DST (Direct Shear Test) also.
- In our project we mainly focused on the performance of plastic waste as soil stabilization material.
- Reducing the number of plastic waste and non-useful materials for foundation work and sub grade improvement.
- We can make our environment pollution free by using waste plastics as a stabilizer.
- This new technique of soil stabilization is effectively wanted to meet the challenges of society and it will considerably enhance the properties of soil utilized in construction of road infrastructure, foundation, stabilization of hill, pavement sub grade and alternative totally different fields as per the requirements and adaptability.

References

[1] Tarun Kumar, Suryaketan, Joyanta "Behaviour of soil by mixing of plastic strips", IRJET, May 2018.
[2] Sayli D. Madavi, Divya Patel, Mamta Burike "Soil stabilization using plastic waste", IJRISE Journal) April 2017.
[3] Sharan Veer Singh, Mahabir Dixit "Stabilization of Soil by Using Waste Plastic Material: A Review", International Journal of Innovative Research in Science, Engineering & Technology, vol. 6, no. 2, February 2017.
[4] Kiran Kumar Patil, Shruti Neeralagi, "Soil Stabilization Using Plastic Waste", International Journal of Advanced Technology in Engineering & Science, vol. 5, no. 7, July 2017.
[5] A. K. Choudhary, J. N. Jha and K. S. Gill "A Study on Behaviour of Waste Plastic Strip Reinforced Soil," in Emirates Journal for Engineering Research, vol. 15, no. 1, pp. 51-57, 2010.
[6] IS: 2720 (part-11)
[7] Gopal Ranjan and A. S. R. Rao, "Basic and Applied Soil Mechanics."