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Soil Stabilization using Plastic Waste Fiber

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ABSTRACT

Soil stabilization is one of the best methods for improving physical properties like shear strength, bearing capacity etc. of the soil. For soil stabilization various admixture such as cement, lime, fly ash, gypsum etc. can be used. But these admixtures are costly so their use for soil stabilization are limited. In some research it is found that utilization of waste material like plastic, bamboo etc. are quite helpful in stabilization of soil. In present world there is scarcity of good soil which makes construction process difficult. So to enhance the properties of soil so that it can be used for various construction there is need to add the suitable admixture in soil. These admixtures should enhance properties of soil and be economical. In this study plastic bottles are used as an admixture. The waste plastic bottles are cut into small strips and these strips are added in the soil in different percentage of 0%, 0.25%, 0.5% and 0.75% of dry weight of soil. Unconfined compressive strength test is conducted in the soil which gives the strength of soil. Along with plastic bottle strips cement is also added in the ratio of 1% and 1.5% of dry weight of soil. After finding out the unconfined compressive strength of different soil sample mixed with different percentage of plastic strips and cement, graphs and tables are plotted for the comparison of strength of different samples of soil.

Keywords: Soil stabilization, Shear strength, Bearing capacity, Plastic, Unconfined compressive strength test

1. INTRODUCTION

Soil stabilization is a process in which, suitable materials such as cement, lime, fly ash bitumen etc are added which helps in increasing the shear strength and bearing capacity of soil, which leads to the improvement of the properties of soil. It controls the shrink as well as swell properties, increases shear and bearing strength of soil, Plastic is a renewable and non-bio-degradable material. The disposal of waste plastic bottles causes environmental pollution. Plastic can be recycled or reused i.e. reprocessing these plastic wastes and make some useful products. Waste of plastics can be used as admixture for stabilized soil. Waste plastic materials can be reused because it can be recycled many times thus reducing the wastage. Use of the plastic waste for the enhancement of the properties of soil, is an effective and economical way of stabilization. Uses of materials made of plastic are increasing day by day, but the disposal of plastic increasing the waste plastickiest in municipal waste. As technology is improving in the society day by day, , a new technique of soil stabilization is find in which waste quantities such as plastic, bamboo, polythene bags, bottles etc, are effectively utilized for enhancing the soil properties. As these waste materials

are increasing in society day by day which leads to different natural problems hence the use of waste plastic materials as an admixture should be imply which increases the strength of the soil , reduces the cost of admixtures and leads to economical use of plastic without causing any environmental and ecological hazards. Stabilized soil is more durable having comparatively high strength, good quality of soil, less permeability of soil and useful for constructions of roads by reducing the thickness of pavement and also control the shrink, swell properties of soil, which helps in achieving better soil gradation. It can significantly improves the working platform for various construction operations.

Stabilization enhances the properties of soil, most importantly it increases the load bearing capacity of soil thus, have a remarkable effect on the strength of soil. Addition of suitable admixtures has the key role in soil stabilization. Generally a good soil is needed for construction, and the stability of structure also depends on the strength of soil which is related to stabilization. If there is stabilized soil, construction willnot get failed because stabilized soil improves the load bearing capacity of soil.

1.1 Objective Of This Study

- To study the change in strength (i.e. stability) of soil with addition of different amount plastic bottle strips amount of 0%,0.25%,0.5% and 0.75% w/w and small amount of cement (1% and 1.5%) with curing period of 3 days.
- Compare the change in strength of soil with varying content of plastic bottle strips with different cement content.
- To find out the optimum plastic bottle strips content (w/w) for maximum strength of soil for different cement content.
- Compare the change in strength of soil with varying content of cement for same amount of plastic bottle strips content(w/w).

2. LITERATURE REVIEW

A lot of researches has been done by researchers for the stabilization of soil.In present world there is scarcity of good soil which makes construction process difficult. Expansive soil are highly problematic soil because of its property of volume change under different moisture condition. There are different types of method available to stabilize the soil but all methods are not economical, so materials which are cheap should be used most times in soil stabilization. So to enhance the properties of soil so that it can be used for various construction there is need to add the suitable admixture in soil. These admixture should enhance properties of soil and also be economical. Some researches that have been done on soil stabilization by adding some admixture is listed below.

Brooks M . Robert et al. [2009] studied about the soil stabilization using fly ash and rice husk ash. He had conducted tests such as Compaction test, UCS, CBR and free swell index. The test results concluded that, by increasing rice husk ash to the soil results in increase of CBR value, UCS andswell deduction. With increased fly ash content, there was an increase in the stress strain behavior of confined compressive strength. He concluded that optimum fly ash and rice husk ash content was found to be 25% and 12% respectively. He also concluded those soils can be highly recommended for strengthening the sub grade of expansive soil.

Choudhary, Jha And Gill[2010] demonstrated the potential of High density polyethylene(HDPE) to convert as soil reinforcement for improving the 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. Their results of CBR tests proves that inclusion of strips cut from reclaimed HDPE is useful as soil reinforcement in highway application.

Lavanya et al. [2011] studied about utilization of copper slag in geotechnical applications. In this paper, she investigated about the Index properties, free swell index, compaction properties, CBR and UCC. She concluded that the partial replacement of copper slag from 30% to 50% with black cotton soils, considerably showed the increase in properties of the soil. She also concluded that partial replacement of copper slag with black cotton soil resulted in utilization of such soils in sub grade, sub base and embankment of roads and it was also improved the sub grade soil condition.

3. MATERIALS AND METHEDOLOGY

Soil- Principal component used for embankment construction and highways subgrade is soil. The performance of pavement especially flexible pavement depends on the type and properties of subgrade soil. In this study soil is taken from Chalapathi which is about 20km away from Guntur. The soil is then passed from 425-micron sieve and the soil passed from the sieve is collected and the test is performed in this soil.

Properties of soil used- Different laboratory test are performed in the soil . Properties of soil obtained from the laboratory test are listed below

Table 1: Basic properties of soil

Properties	Results
SpecificGravity	2.31
Liquid Limit (LL) %	57.5
Plastic Limit(PL)%	22
Shrinkage Limit	19.2
Plasticity index $(I)_p$	35.5
OMC %	14.7
MDD (KN/m³)	17.1

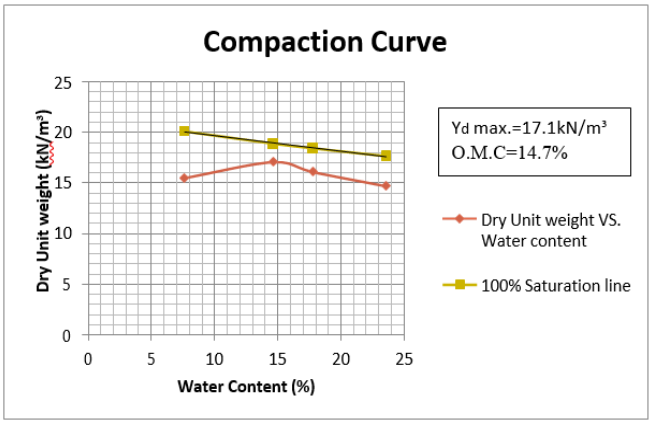

Figure 1: compaction curve

Cement- Along with plastic strips some amount of cement is also added as cement is also a admixture which can improve or enhance properties of soil. After adding cement and plastic strips in the soil it is cured for 3 days and then test is performed in the soil.

Waste Plastic Strips- Cold drink bottles are collected and cut into strips of aspect ratio two. The dimensions of waste plastic bottle strips used in this study is 7.5mm × 15mm. These strips are added in the soil- cement mixture in different proportion by weight. In this study strips used are 0%, 0.25%, 0.5% and 0.75% of dry weight of soil. A Picture of strips is shown below.

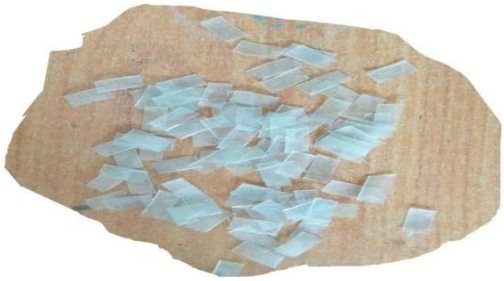

Figure 2: Waste Plastic Strips

Unconfined Compression Test Unconfined compression test is a special type of triaxial test in which confining pressure is zero i.e (σ_3=0). It means that there is no first stage(confining pressure stage) because confining pressure is zero,therefore no rubber membrane is required in this test. Without rubber membrane dry soil andsand cannot be held in position hence this test can be conducted in saturated silt and clay but it ismore suitable for clay. The saturated sample is subjected to axial loading, then deviator stress at failure($\sigma_{d)f}$ is termed as unconfined compressive strength(q_u). So $q_u = (\sigma_d)_f$

4. RESULTS AND DISCUSSIONS

In this project unconfined compression test is performed which gives the strength of soil. Prior to this proctor test is done to find the optimum moisture content of the soil which is found to be 15%. The soil in which test is conducted is collected from Chalapathi which is located at around 20 km away from Guntur. The unconfined test is conducted on triaxial apparatus. Results obtained from the test are drawn into graphs and comparison is done between soil sample mixed with different proportion of cement and plastic strips. Graphs are drawn between stress and percentage strain values. Stress- strain curve of normal soil without any admixture is shown below.

Sample 1- In this sample no cement and plastic strips are added. UCS test is being carried out and stress vs strain curve are plotted.

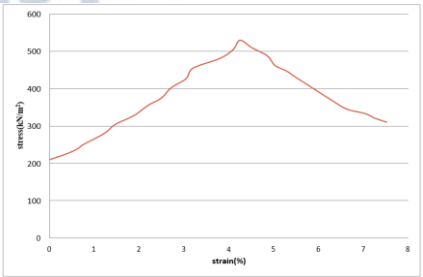

Figure 3: stress vs strain curve of normal soil

From the stress vs strain curve it is clear that the strength of this soil sample having no admixture is 530KN/m².

In this comparison, stress vs strain curve of four samples are compared. samples containing 1% cement and plastic strips content of 0%,0.25%,0.5%,0.75% are compared by plottingstress vs strain curve.

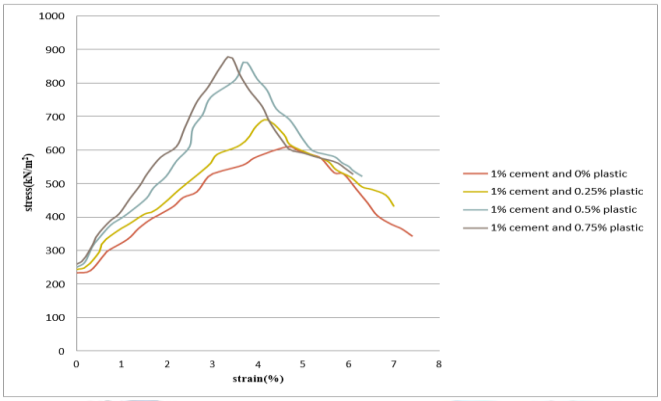

Figure 4: comparison of stress vs strain curve between soil samples containing 1% cement andplastic strips of 0%,0.25%0.5%,0.75%.

From the stress vs strain curve of soil samples having fixed quantity of cement of 1% and varying plastic content of 0%,0.25%,0.5% and 0.75% it is clear that the strength of soil having fix cement quantity of 1%, increases by increasing plastic strips content upto 0.5% . increasing the plastic strips content beyond shows decrease in the strength of soil. So it can be said that the optimum plastic content of the soil is 0.5%.

This comparison four soil sample are taken and their stress vs strain curve are plotted in the same curve. From the curve comparison between different samples of fixed cement quantity of 1.5% and different plastic strip content of 0%,0.25%,0.5% and 0.75% is done.

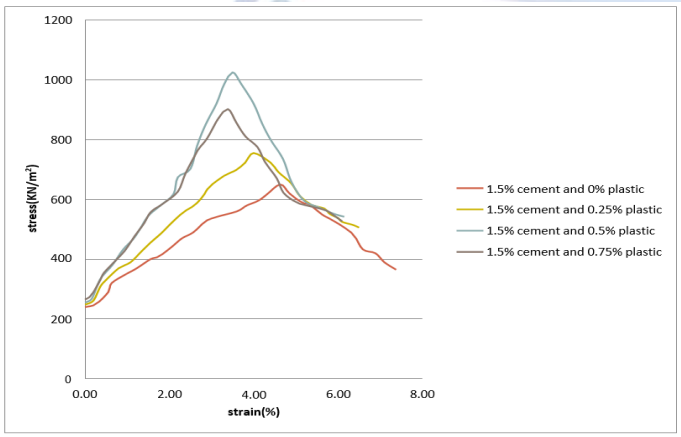

Figure 5: comparison of strength between soil samples containing 1.5% cement and plastic strips of 0%,0.25%,0.5% and 0.75% respectively.

From the stress vs strain curve of soil samples having fixed quantity of cement of 1.5% and varying plastic content of 0%,0.25%,0.5% and 0.75% it is clear that the strength of soil having fix cement quantity of 1.5%, increases by increasing plastic strips content up to 0.5% . Increasing the plastic strips content beyond shows decrease in the strength of soil. So it can be said that the optimum plastic content of the soil is 0.5%.

After conducting test on all the samples a table is prepared representing unconfined compressivestrength of all soil samples.

Table 2: UCS value of different soil samples

Soil sample no.	Cement Content (%) by dry weight	Plastic strip (%) by dry weight	Unconfined compressive strength (KN/m²)
1	0	0	530
2	1%	0	610
3	1.5%	0	650
4	1%	0.25%	690
5	1.5%	0.25%	755
6	1%	0.5%	865
7	**1.5%**	**0.5%**	**1025**
8	1%	0.75%	880
9	1.5%	0.75%	904

Observing the above table, increase in cement quantity from 1% to 1.5% results in increase in the strength of soil and increase in the plastic strip content upto 0.5% will increase the strength of soil. But increasing the plastic strip content beyond 0.5% results in decrease in the strengthof soil.

5. CONCLUSIONS

After conducting test and observing the results obtained, following conclusions can be made-

1. There is an increase in strength of soil with increase in the amount of cement added to the soil.
2. The soil having 1% cement and 0% plastic bottle strips content has an strength of 610KN/m² while soil sample having 1.5% cement and 0% plastic bottle strips has an strength of 650KN/m².
3. Srikanth N, Experimental Investigation on Strength and Toughness Properties of Self Compacting Concrete Mineral Admixtures, Test Engineering

Management, March - April 2020 ISSN: 0193-4120 Page No. 17246 – 17253.

4. There is also increase in the strength of soil by increasing the amount of plastic bottle strips added to the soil.
5. The strength of soil without any admixture is 530KN/m², which increases upto 1025 KN/m² at a cement content of 1.5% and plastic bottle strips content of 0.5%.
6. But increasing the amount of plastic bottle strips beyond 0.5% of weight of dry soil will decrease the strength of soil.
7. After increasing the plastic bottle strips beyond 0.5% to 0.75% ,there is decrease in the strength of soil. The strength of soil at 1.5% cement content and 0.5% plastic bottle strips is 1025 KN/m² which decreases to 904KN/m² at a cement content of 1.5% and plastic bottle stripcontent of 0.75%.
8. So the optimum amount of plastic bottle strips to be added to enhance the strength of soil is 0.5% at a cement content of 1.5%.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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