International Journal of Engineering, Science and Mathematics
Vol. 6 Issue 8, December 2017 (Special Issue)
ISSN: 2320-0294 Impact Factor: 6.765
Journal Homepage: http://www.ijesm.co.in, Email: ijesmj@gmail.com Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gage as well as in Cabell's Directories of Publishing Opportunities, U.S.A

Soil Stabilization Using Plastics

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Abstract

It reflects that plastic wastes can be used in stabilization of soil which is concluded from various tests conducted on fiber reinforced soil with varying fiber content. In this study, different means of plastic waste as shopping bags which are locally available are used so as a reinforcement to perform unconfined compressive test while mixing with soil for improving engineering performance of sub grade soil. In this the plastic strips which are collected for stabilization of soil were mixed randomly with the soil. With this a series of tests were carried out on randomly reinforced soil with varying percentage of plastic strips starting from 0, 0.5%, 1.5% and 2.5%. Use of plastic in soil in an appropriate amount really aids in improving the strength of soil and can be useful as sub grade soil which can be used in pavement construction.

Keywords:

Stabilization;
Unconfined Compressive Strength;
Fiber Reinforced Soil;
Soil Properties;
Shear Strength.

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1. Introduction

In early 1970 s soil stabilization started in India, it's necessary for the engineers to improve soil rather than replacing the poor soil at site.It is utilizeddue to the use of obsolete methods, absence of proper technical method. In recent times, with the increase in the demand for construction materials and fuel, this stabilization has begun to take a new turn. With the availability of good research, materials and instruments, it is appear as a famous and economical method for soil strengtheing

Soil stabilization is the methodof involve some properties by various methods like mechanical or chemical in order to givegood soil material which has all the necessary engineering properties.

Soils are for the most part balanced out to enhance their quality, solidness, dispense with disintegration and clean development in soils.The usage of soil stabilization depends on soil testing. Different methodsare engage to stabilize soil and the method should be confirmed in the lab with the soil material formerly applying it on the field.

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Soil StabilizationPrinciples

i. Calculate the soil properties of the area under consideration.
ii. Assess the property of soil which should be changed to get the outline esteem and pick the financially savvy technique for adjustment.
iii. Plan the Stabilized soil mix and testing it in the lab for good soil properties.

Advantages

The soil properties are playing a great role in construction dependingon the bearing capacity of the soil. The gradation of the soil is an important parameter while working with soils so that is better to mix different types of soils together to improve the soil strength. It increases the strength of the soil by increasing bearing capacity of the soil.

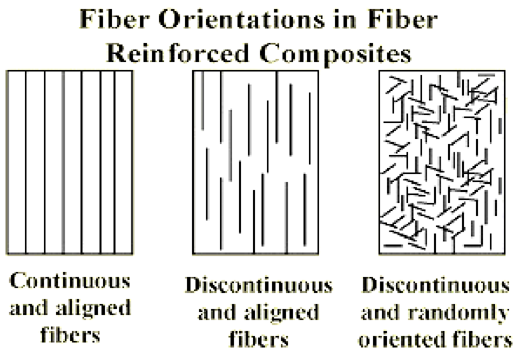
i. Soil stabilization is morecost effective technique and energyefficient technique.
ii. Soil stabilization is used to give more stability to the soil material.
iii. Sporadically it is also used to prevent formation of dust orsoil erosion, which is very useful especially in dry and arid weather.
iv. SoilStabilization is also done for soil water-proofing which prevents water from entering into the soil and helps the soil from losing its strength.
v. Soil Stabilizationdecrese the volume change of soilwith water content.

2. Method ofAdditive Stabilization

Itexplains about addition of manufactured items into the soil with good quantities toimprove the quality of the soil.Fly ash,cement, lime, bitumen, etc. These are utilized as additives. Sometimes different fibers are also used as reinforcements in the soil.Random fiber reinforcement is good for stabilization.

Randomfiberreinforcement

This placement of fiber has discrete assigned fibers randomly in the soil mass. Combination is done and the reinforcement forms more or less homogeneous.Randomly allocated fibers have some benefits over the systematically distributed fibers. Thistype of reinforcement is similar to addition of admixtures such as lime,cement, etc. alongside being easy to add and mix, this method also offers strength isotropy, decreases chance of potential weak planes which happened in the other case and provides ductility to the soil.



FiberOrientation

Soil Properties

1. Plastic Limit

The state which is in between plastic and semi solid state is coined as plastic limit. The soil sample is rolled in to a thread on a flat surface and the soil just crumbled at around 3 mm diameter. Plastic limit is denoted by $P_{L.}$

Plastic Limit

2. **Liquid Limit**

The state which is in between liquid state and plastic state is reffered as liquid limit. It is a minimum water content showing shearing strength when it is flowing and determined by Casagrande's apparatus. The liquid limit is denoted by $L_{L.}$

Liquid Limit by Casagrander's Apparatus

3. **Shrinkage Limit**

It is ratio of total soil sample to the volume of the voids. It is denoted by $S_{L.}$

Particle Size Distribution

In soil sample at any place is composed of particles of a variety of sizes and shapes, sizes ranging from a few microns to a few centimeters are present. Distribution of particles of different sizes determines many physical properties of the soil such as itspermeability, strength, density etc.

Particle size distribution is found out by two methods, first is sieve analysis which is done for coarse grained soils only and the other method is sedimentation analysis used for fine grained soil sample. Both are followed by plotting the results on a semi-log graph.

For analysis of the particle distribution, we use D_{10}, D_{30}, and D_{60} etc. terms which represents a size in mm such that 10%, 30% and 60% of particles respectively are finer than that size. The term called uniformity coefficient C_u comes from the ratio of D_{60} and D_{10}, it gives a measure of the range of the particle size of the soil.

Sieve Shaker

Specific Gravity

It is defined as the ratio between the mass of any substance of a definite volume divided by mass of equal volume of water.In case of soils, specific gravity is the number of times the soil solids are heavier than equal volume of water. Different types of soil have different specific gravities, general range for specific gravity of soils

Sand	2.63-2.67
Silt	2.65-2.7
Clay and Silty clay	2.67-2.9
Organic soil	<2.9

Pyconometer Apparatus for Specific Gravity

Shear Strength

Shearing stresses are induced in a loaded soil and when these stresses reach their limiting value, deformation starts in the soil which leads to failure of the soil mass. The shear strength of a soil is its resistance to the deformation caused by the shear stresses acting on the loaded soil. The shear strength of a soil is one of the most important characteristics.

We have several experiments those are used to determine shear strength such as UCSor DST etc. The shear resistance offered is made up of three parts:

a) The structural resistance to the soil displacement caused due to the soil particles getting interlocked,

b) The frictional resistance at the contact point of various particles, and
c) Cohesion or adhesion between the surfaces of the particles.

Cohesion less soils shear strength is entirely dependent upon the frictional resistance, while in others it comes from the internal friction as well as the cohesion.

Measuring Shear Strength (UCS Test)

Unconfined Compression Test

This test is a specific case of triaxial test where the horizontal forces acting are zero. There is no confining pressure in this test and the soil sample tested is subjected to vertical loading only. The sampleis used as cylindrical and is loaded till it fails due to shear.

Unconfined Compressive Testing Machine

MATERIALS

- **Soil sample:**Behind Pepsi showroom, P.M. Palem, Visakhapatnam.
- **Reinforcement:**Polyethene fibers.

Index and Strength Parameters of Polyethene-Fiber

Behavior parameters	**Values**
Fiber type	Single fiber
Unit weight	0.91 gm/cm^3
Average diameter	0.034mm
Average length	12mm
Breaking tensile strength	350Mpa
Fusion point	3500MPa
Burning point	590^{0}c
Acid and alkali resistance	very good
Dispersibility	Excellent


Platic bag strips used as reinforcement

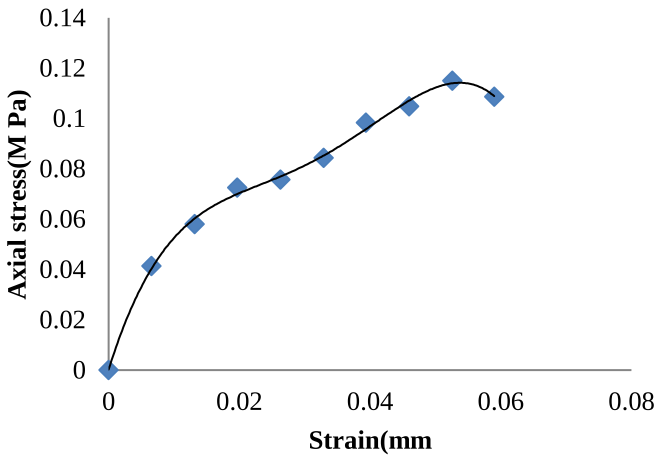
Unconfined Compressive Strength

Unreinforced

Initial height h (mm)	76
Initial diameter d (mm)	38
Initial area A(mm^2)	1134.11

UCS of unreinforced soil

S. no	Dial guage reading	Strain (mm)	Corrected area	Proving ring reading	Axial load (N)	Compressive strength (MPa)
1	0	0	11.34	0	0	0
2	50	0.00658	11.42	22	47.3	0.041
3	100	0.0131	11.49	31	66.65	0.059
4	150	0.0197	11.57	39	83.85	0.074
5	200	0.0263	11.65	41	88.15	0.077
6	250	0.0329	11.73	46	98.90	0.085
7	300	0.0394	11.81	54	116.1	0.098
8	350	0.0460	11.89	58	124.7	0.105
9	400	0.0526	11.97	64	137.6	0.114



UCS graph for unreinforced soil

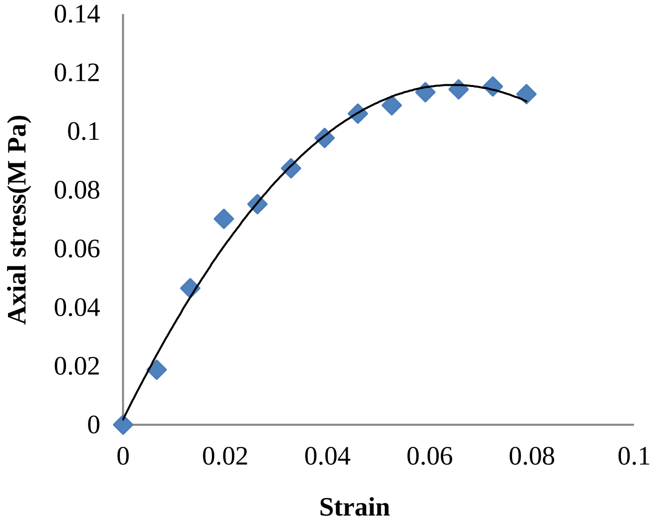
UCS unreinforced soil specimens

As obtained from graph UCS=0.114MPa

Reinforcement 0.5%

UCS with 0.5% reinforcement

S. no	Dial gauge reading	Strain (mm)	Corrected area	Proving ring reading	Axial load (N)	Compressive strength (Mpa)
1	0	0	11.34	0	0	0
2	50	0.00658	11.42	1	2.15	0.002
3	100	0.0131	11.49	10	21.50	0.019
4	150	0.0197	11.57	25	53.75	0.047
5	200	0.0263	11.65	38	81.70	0.070
6	250	0.0329	11.73	41	88.15	0.075
7	300	0.0394	11.81	48	103.20	0.087
8	350	0.0460	11.89	54	116.10	0.098
9	400	0.0526	11.97	59	126.85	0.106
10	450	0.0592	12.05	61	131.15	0.109
11	500	0.0657	12.13	64	137.60	0.113
12	550	0.0723	12.22	65	139.75	0.114
13	600	0.0789	12.31	66	141.90	0.115
14	650	0.0855	12.40	65	139.75	0.112



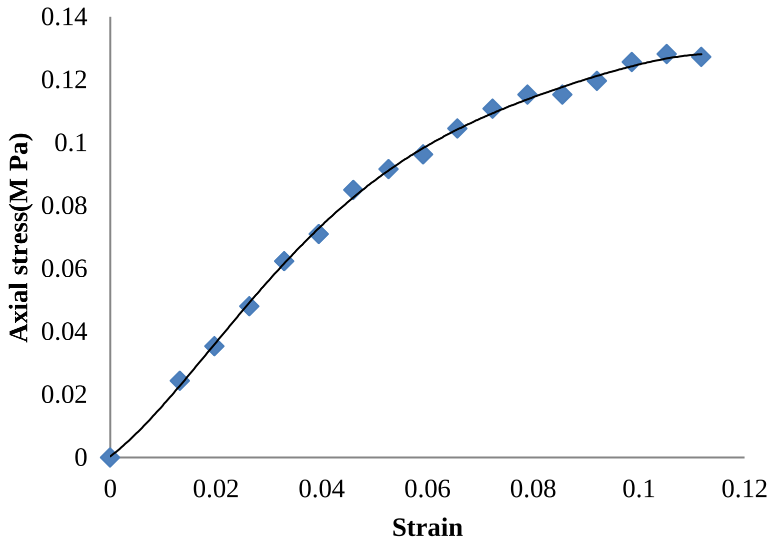
UCS graph for 0.5% reinforcement

soil specimens with 0.5% reinforcement

As obtained from the graph UCS=0.1152 MPa

Reinforcement 1.5%

S. no	Dial gauge reading	Strain (mm)	Corrected area	Proving ring reading	Axial load (N)	Compressive strength (MPa)
1	0	0	11.34	0	0	0
2	50	0.00658	11.42	2	4.30	0.004
3	100	0.0131	11.49	13	27.95	0.024
4	150	0.0197	11.57	19	40.85	0.035
5	200	0.0263	11.65	26	55.90	0.048
6	250	0.0329	11.73	34	73.10	0.062
7	300	0.0394	11.81	39	83.85	0.071
8	350	0.0460	11.89	47	101.05	0.085
9	400	0.0526	11.97	51	109.65	0.092
10	450	0.0592	12.05	54	116.10	0.096
11	500	0.0657	12.13	59	126.85	0.104
12	550	0.0723	12.22	63	135.45	0.111
13	600	0.0789	12.31	66	141.90	0.115
14	650	0.0855	12.40	69	148.35	0.119
15	700	0.0921	12.49	73	156.91	0.126
16	750	0.0986	12.58	75	161.25	0.128
17	800	0.1052	12.67	75	161.25	0.127
18	850	0.1118	12.76	72	154.80	0.121

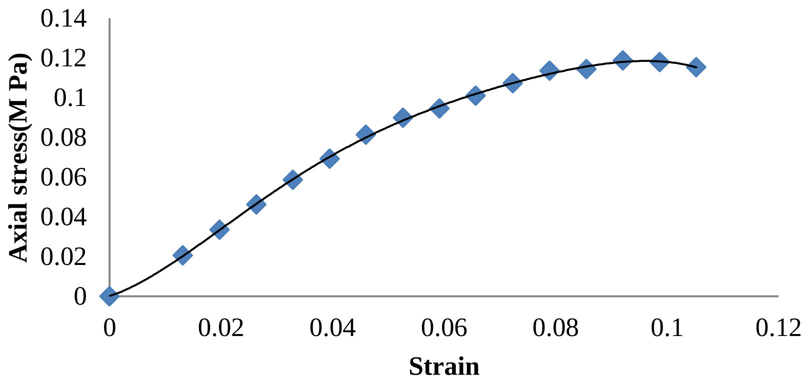


UCS graph with 1.5% reinforcement **soil specimen with 1.5% reinforcement**

As obtained from the graph UCS=0.128 MPa

Reinforcement 2.5%

S. no	Dial gauge reading	Strain (mm)	Corrected area	Proving ring reading	Axial load (N)	Compressive strength (MPa)
1	0	0	11.34	0	0	0
2	50	0.00658	11.42	1	2.15	0.002
3	100	0.0131	11.49	11	23.65	0.021
4	150	0.0197	11.57	18	38.70	0.033
5	200	0.0263	11.65	25	53.75	0.046
6	250	0.0329	11.73	32	68.80	0.059
7	300	0.0394	11.81	38	81.70	0.069
8	350	0.0460	11.89	45	96.75	0.081
9	400	0.0526	11.97	50	107.50	0.089
10	450	0.0592	12.05	53	113.95	0.095
11	500	0.0657	12.13	57	122.55	0.101
12	550	0.0723	12.22	61	131.15	0.107
13	600	0.0789	12.31	65	139.75	0.113
14	650	0.0855	12.40	66	141.90	0.114
15	700	0.0921	12.49	69	148.35	0.119
16	750	0.0986	12.58	69	148.35	0.118
17	800	0.1052	12.67	68	146.20	0.115



UCS curve with 2.5% reinforcement

As obtained from the graph UCS=0.119 MPa

Conclusion

On the basis of current experimental study, the following conclusions are drawn

In present study, the value in unconfined compressive test shows that there is increase of 0.114 MPa to 0.115 MPa when 0.5% of reinforcement is added. And further the strength is increased to 0.128 MPa when 1.5% of reinforcement is added to it. There is sudden decrease in the strength when 2.5% of reinforcement is added to 0.116 MPa which is reduced by 7.81%. The results obtained are compared with unreinforced soil shows that there is an increase of 12.3% of strength when 1.5% of reinforcement is added to it. The results show positive correlation and hence the plastic bag strips for soil reinforcement can we use in pavement design in civil engineering applications.

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