Soil Stabilization by Using Raw Plastic

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ABSTRACT:

The best method for improving the physical properties of the soil like; increasing strength such as shear strength, bearing capacity etc. is the process of soil stabilization. This process includes addition of the admixtures into the soil in order to increase the properties of the soil. The admixtures such as; cement, lime ad waste materials like fly-ash, phosphor gypsum, etc. are very expensive materials. The cost of these kind of admixtures is increasing day by day as the technology is improving around the every corner of the society. In recent technology research, utilization of the waste materials likes plastic, bamboo etc. The widely used thing in today's society is the plastic. The disposal of these plastic wastes causes the ecological hazards, a big is a useful thing in stabilization. In the modern world, there is a scarcity of a good soil. Since the low availability of un-stabilized soils makes it difficult admixtures to the soil. These plastic waste materials like plastic bottles are used in this project. For this to happen the plastic bottles are cut down into small strip like pieces. The addition of these small strips in the soil by different percentage and conduct tests such as liquid limit, plastic limit, compaction test, CBR test etc. Then soil becomes stabilized i.e, increasing the load bearing capacity of the soil and also strength properties such as shear strength with a controlled compaction. Soil stabilization by using waste plastic bottles which significantly enhance the strength properties of the soil.

KEY WORDS: Soil Stabilization, Lime, Portland Cement, Raw Plastic, Plastic bottles.

INTRODUCTION

1.1.1 GENERAL:

Soil stabilization is a process, can be made by adding suitable admixtures such as cement, lime, fly ash (waste materials) phosphor gypsum etc, whisk increases the shear strength, bearing capacity to, that leads to improve the physical properties of soil. Soil Stabilization increases the bearing capacity by adding suitable admixtures, plastic bottle strips are used as an admixture. The utilization of waste plastic materials into a useful material for the stabilization of the soil. It controls the shrink-swell properties, increases shear strength of soil, swelling potential should be reduced that leads to increases the durability and strength. Plastic is a non-renewable source and bio-degradable. The disposal of waste plastic bottles causes environmental pollution, it's a sustainable waste.

1.1.2 NEEDS AND ADVANTAGES

Soil vary a great deal and construction of structures depends a lot on the bearing capacity of the soil, hence, we need to stabilize the soil which makes it easier to predict the load bearing capacity of the soil and even improve the load bearing capacity. The gradation of the soil is also a very important property to keep in mind while working with soils. The soils may be well-graded which is desirable as it has less number of voids or uniformly graded which though sounds stable but has more voids. Thus, it is better to mix different types of soils together to improve the soil strength properties.

1.1.3 MECHANISM OF STABILIZAION

The stabilization mechanism may vary widely from the formation of new compounds binding the finer soil particles to coating particle surfaces by the additive to limit the moisture sensitivity. Therefore, a basic understanding of the stabilization mechanisms involved with each additive is required before selecting an effective stabilizer suited for a specific application. Chemical stabilization involves mixing or injecting the soil with chemically active compounds such as Portland cement, lime, fly ash, calcium or sodium chloride or with viscoelastic materials such as bitumen.

1.2 SOILS

Soil can be defined as all materials that are founded on the earth's crust surface layer and are gentle enough to be moved by simple shovel. Soil normally consists of solid, liquid and gaseous materials. The liquid materials usually are electrolyte solutions, the solids are organic and inorganic substances, while the gaseous are on the location of the soil itself as it differ the location, the gases also differ because it depends on organic and inorganic characters that is available on that location.

1.2.1 SOIL PROPERTIES

Since there are very wide differences in soil types, soil classification has become very important especially for the field of geotechnical civil engineering. "Index properties" is a type of classification that is based on the classification and identification of soil properties. Typical examples of index properties are; liquid limit, plastic limit and plasticity index. The liquid limit is defined as the water content in which the clayey soil changes from hardened state to liquid state.

PI	Classification
0-3	Non-plastic
3-15	Slightly plastic
15-30	Medium plastic
>30	Highly plastic

1.2.2 NATURAL SOILS

Natural soil means soil that has developed through natural processes and to which no fill material artificially placed soil has been added. The soil condition at the site, which covers an area about 100ft by 50ft, are quite uniform. The soil profile revealed by six borings and two pits was as follows.

1.3 SOIL PROPERTIES:

ATTERBERG LIMITS

1. Shrinkage Limit:

This limit is achieved when further loss of water from the soil does not reduce the volume of the soil. It can be more accurately defined as the lowest water content at which the soil can still be completely saturated. It is denoted by Ws.

2) Plastic Limit:

This limit lies between the plastic and semi-solid state of the soil. It is determined by rolling out a thread of the soil on a flat surface which is non-porous. It is the minimum water content at which the soil just begins to crumble while rolling into a thread of approximately 3mm diameter. Plastic limit is denoted by Wp.

3) Liquid Limit:

It is the water content of the soil between the liquid state and plastic state of the soil. It can be defined as the minimum water content at which the soil, though in liquid state, shows small shearing strength against flowing. It is measured by the Casagrande's apparatus and is denoted by Wl

1.4 SIGNIFICANCE OF THE PROBLEM

Soil stabilization is very important to the construction of buildings because there are certain places where construction of buildings is going to be taken place in it include problematic soil. The definition of problematic soil is the soil that causes problems due to its components or due to a change in the climate, typical examples of these problematic soils are acidic soils, alkaline soils, sodic soil and saline soil. For acidic and alkaline soil they can be stabilized by adding chemicals that modify and manipulate the Ph of soil such as limestone and thus it will tend to stabilize.

1.5 OBJECTIVES OF THE STUDY

1.Utilization of waste plastic materials as an admixture for soil stabilization. Increase the shear quality of soil and load bearing limit of soil.
2.Increase the higher resistance values by controlling shrink-swell properties of the soil.
3.Reduces plasticity index, lower permeability and reduction of pavement thickness by increases the bearing capacity of soil sub grade i.e. addition of raw plastic bottles.
4.Improving the soil gradation, useful for construction of good pavement.
5.Increases the durability and strength of the soil.

1.5.1 NEEDS AND ADVANTAGES OF SOIL STABILIZATION

Soil properties vary a great deal and construction of structures depends a lot on the bearing capacity of the soil, hence, we need to stabilize the soil which makes it easier to predict the load bearing capacity of the soil and even improve the load bearing capacity. The gradation of the soil is also a very important property to keep in mind while working with the soils. The soils may be well graded which is desirable as it has less number of voids or uniformly graded which though sounds stable but has more voids.

CHAPTER -2
LITERATURE REVIEW

Industrial development in India has necessitated construction of infrastructure facility such as highways, airports seaports and residential, commercial buildings. There is a need to select a good soil conditions for proper safety consideration of all these projects. Such soils exhibit extreme stages of consistency from very hard to very soft when saturated. Expansive soils contain minerals that are capable of absorbing water. They undergo severe volume changes corresponding to changes in moisture content. They swell or increase in their volume when they imbibe water and shrink or reduce in their volume on evaporation of water (Chen 1998). Because of their alternate swelling and shrinkage, they result in detrimental cracking of lightly loaded civil engineering structures such as foundations, retaining walls, pavements, airports, side -walks, canal beds and linings (Chen 1988).

1.Harish and Ashwini, H.M. (2016): studied the effect of plastic bottles strips as a stabilizer for two soil samples, red soil and black cotton soil. Red soil consists of 4 % gravel, 88% sand and 8% silt and clay and black cotton soil 2.6% gravel, there was an increase in the strength of the soil. Authors conducted a CBR ratio test to find out MDD and OMC. They observed an increase in the strength of soil and bearing ratio of 2.9 for red soil and 3.3 for the black cotton soil by mixing 0.7 % of waste plastic strips to red soil and 0.5% for the black cotton soil.

2.Satyam Tiwari and Nisheet Tiwari (2016): Investigated the effect of waste polypropylene fiber on shear strength of unsaturated soil samples. Here, the percentage of specific gravity of the soil increases 0.3% by using 0.5% of fiber (PPF).

3.Choudhary et.al. (2010): performed a laboratory evaluation on utilization of plastic wastes for improving the subgrade in flexible pavement. In this study the effect of waste plastic strip content (0.25% to 4%) and strip length on the CBR and secant modulus of strip reinforced soil was investigated. The study reveals

4.Akshat Malhotra et.al. (2014): demonstrated the potential 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 was added, 287.32 KN/m2 soil strength of the soil was obtained which was more than untreated soil.

CHAPTER 3
METHODOLOGY

3.1 MATERIALS USED:
In order to conduct this study, various materials such as sandy soil, plastic bags (both perforated and unperforated) were used.

Plastic Material:
The plastic bags were sourced from a local supermarket and shredded into strips of varying lengths and widths using a laser cutting machine. The bags were labeled as high density polyethylene (HDPE) according to the plastics identification code by the American Society of the Plastics Industry (SPI). The density measured as 743 kg/m3 with an average thickness of 40 µm and a tensile modulus of 389.7 MPa. The tensile strength obtained for the plastic material varied between 15 MPa and 20 MPa. Both the solid strips and perforated strips were included in the testing regime. For perforated strips, the laser cutting machine was used to make perforations of different diameters on the strips

Red Soil:
Red soil is a type of soil that typically develops in warm, temperate, and humid climates and comprises approximately 13% of Earth's soils. It contains thin organic and organic-mineral layers of highly leached soil resting on a red layer of alluvium. Red soils contain large amounts of clay and are generally derived from the weathering of ancient crystalline and metamorphic rock. They are named after their rich red color, varying from reddish brown to reddish yellow due to their high iron content. Red soil can be good or poor growing soil depending on how it is managed. It is usually low in nutrients and humus and can be difficult to cultivate due to its low water holding capacity; however, the fertility of these soils can be optimized with liming and other farming techniques.

Raw Plastic bottle strips:
Plastic is a non-renewable source and bio-degradable. The disposal of waste plastic bottles causes environmental pollution, it's a sustainable waste. Plastic can be recycled or reused i.e. reprocessing these plastic wastes makes the useful products. Such wastes of plastics be used as additives for stabilized soil

3.2 METHODS OF STABILIZATION:
[1] The Standard Proctor Compaction tests were 5done to assess the amount of compaction and the water content required in the field. The water content at which the maximum dry density is attained is obtained from the relationships provided by the tests.

[2] Plate load tests were conducted with plain lateritic soil, soil stabilized with full bottles, soil stabilized with bottles cut to two halves and soil stabilized with optimum percentage of plastic strips.

CHAPTER 4
TESTS CONDUCTED ON SOIL
4.1 SIEVE ANALYSIS
AIM: This test is performed to determine the percentage of different grain sizes contained within a soil. The mechanical or sieve analysis is performed to determine the distribution of the coarser, larger-sized particles, and the hydrometer method is used to determine the distribution of the finer particles.

TEST PROCEDURE:
(1).Write down the weight of each sieve as well as the bottom pan to be used in the analysis. (2). Record the weight of the given dry soil sample. (3). Make sure that all the sieves are clean, and assemble them in the ascending order of sieve (#4 sieve at top and #200 sieve at bottom). Place the pan below #200 sieve. Carefully pour the soil sample into the top sieve and place the cap over it. (4). Place the sieve stack in the mechanical shaker and shake for 10 minutes. (5). Remove the stack from shaker and carefully weigh and record the weight of each sieve with its retained soil. In addition, remember to weigh and record the weight of the bottom pan with its retained fine soil.

From graph, D=60=0.64

D30=0.23

D10=0.008

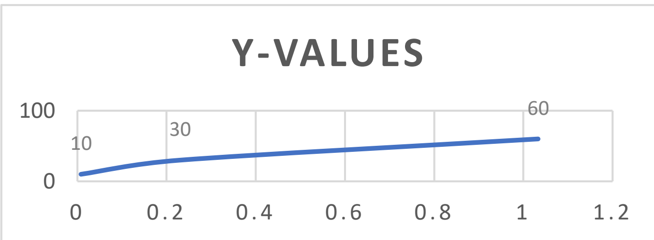
Cu=D60/D10

Cu =0.64/0.008=8

Cc = D30/D60*D10=1.033

D 60

GRAPH:



GRAPH – 4.1

RESULT:

Therefore the soil is well graded sandy soil.

4.2 COMPACTION TEST:

AIM:

This method covers the determination of the relationship between the moisture content and density of soils compacted in a mound of a given size with a 2.5 kg rammer dropped from a height of 30 cm.

PROCEDURE:

Take a representative oven-dried sample, approximately 5 kg in the given pan. Thoroughly mix the sample with sufficient water to dampen it to approximately four to six percentage points below optimum moisture content. (1). Weight the mould without base plate and collar. Fix the collar and base plate. Place the soil in the proctor mould and compact it in 3 layers giving 25 blows per layer with 2.5 kg rammer falling through. (2). Remove the collar, trim the compact soil even with the top of the mould by means of the straight edge and weigh. (3). Divide the weight of the compacted specimen by 944 cc and record the result as the wet weight in grams per cubic centimeter of the compacted soil. (4).Remove the sample from mould and slice vertically through and obtain a small sample for moisture determination. (5).Thoroughly break up the remainder of the material until it pass a no.4 sieve as judged by the eye. Add water in sufficient amount to increase the moisture content of the soil sample by one or two percentage points and repeat the above procedure for each increment of water added.

CALUCULATIONS:

Wet density gm\cc = weight of compacted soil/944.

Dry density wt density / (1 + w) .

Where w is the moisture content of the soil.

Plot the dry density against moisture content and find out maximum dry density and optimum moisture for the soil.

Saturation = G Ɣ / (1 + g / G W)

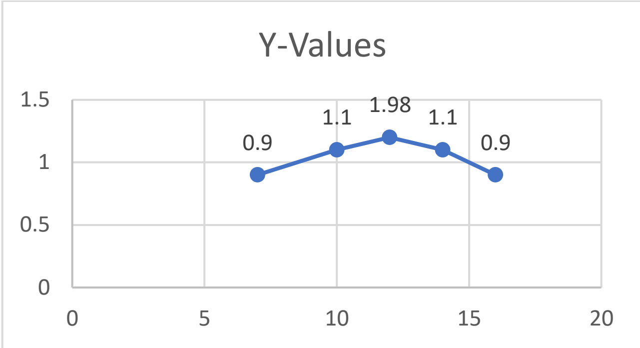
100% saturation line:

10% water content = (2.63*1) / (1+(2.63*0.10)) = 2.082

12% water content = (2.63*1) / (1+ (2.63*0.12)) = 1.999

14% water content (2.63*1) / (1+ (2.63*0.14)) = 1.922

GRAPH :



RESULT :

Maximum dry density for this soil is 1.98gm/cc and optimum moisture water content is 12%.

4.3 DIRECT SHEAR TEST

AIM: To determine the shear parameters for the taken soil sample

PROCEDURE

(1). The internal dimensions of the shear box are measured. (2). The upper part and lower part are fixed to the box by locking screws attach to the base plate to the lower part. (3). The grid plates are then placed in the shear box keeping their graduations perpendicular to the plane of shear. (4). The shear box along with grid plates, base plates are weighted. (5). The soil specimen is now placed in shear box if clay are filled if sand up to a depth 15mm from top is lift free then the sample is leveled.

(6). The shear box along with the specimen is weighted.

(7). The sear box is now placed on the loading frame and loads are added to the loading pad (8). The upper half part of the shear box is made in contact with the poring ring.

(9). The dial gauge are settled up one is placed to record displacement and another dial gauge to container to record horizontal displacement. Apply a normal stress of 0.25 kn/sq.mt note the readings of the vertical displacement dial gauge. (10). Adjust all the dial gauge to read zero the proving should also zero. (11). Applying the horizontal shear load at constant rate of strain 0.2mm/min

(12). Continue the test till the specimen fails (or) till a strain of 20% reached.(13). Repeat the experiment further normal stress on identical specimen.

Sample no.	Normal load	Proving ring reading	Shear load (N)	Shear load (Kg)	Shear stress (kg/cm2)
1	0.5	21	64.48	6.594	0.189
2	1.0	29	89.33	9.106	0.262
3.	1.5	41	126.3	12.87	0.372

RESULT :

The final readings of shear stress is 0.189,0.269,0.372 kg/cm.

4.4CALIFORNIA BEARING RATIO TEST

AIM: To determine the C.B.R value of the given sample

PROCEDURE:-

The sample is obtained by collecting material passing through 20mm I.S sieve about 4.5 kg to 5.5 kg of the material is taken and mixed thoroughly with required water content. The extension collar is now placed upon the mould; also fix the bottom to the base plate. Place a spacer disc at bottom and fill in the soil in layers as mentioned by I.S light compaction test (or) I.S heavy compaction lost

The extension collar is then removed after filling the mould with sample. The edge are fine trimmed to the level of the mould. Looser the base plate and remove the base plate and spacer disk. The mould is now weighed with the compacted soil. Place annular masses like spacer disk with central hole, to produce a surcharge equal to mass of the base material and wearing cat of the expected pavement. The mould is now placed on the bottom plates of the apparatus. The plunger is adjusted centrally such that it penetrate when load is applied.

The plunger should be kept just contact with soil specimen such that penetration occurs on applying load. The plunger should be kept just contact with soil specimen such that penetration occurs on applying load.Set the load dial gauge to displacement dial gauge to zero.The load is applied on the plunger such that the rate of penetration is 1.25mm/min. At the end of the test soil specimen is taken for water content determination. The corresponding dial gauge reading for 2.5mm and 5mm penetration are determined. In general C.B.R is reported as value at 2.5mm penetration. If which is more than that is at 5mm

S.NO	Penetration guage		Load dial guage	
	Dial guage readings	Penetration (mm)	Dial guage readings	Load (N)
1	0	0.0	8	0.018
2	50	0.5	14	0.033
3	100	1.0	27	0.063
4	150	1.5	124	0.29
5	200	2.0	215	0.505
6	250	2.5	313	0.736
7	300	3.0	420	0.987
8	350	3.5	487	1.125

C.B.R AT 2.5mm PENETRATION (LOAD AT 2.5mm/13.44) ×100

= (0.736/13.44) ×100

=5.47%.

RESULTS:

There is increase in bearing capacity value by 5.47%.

5.TESTS CONDUCTED ON SOIL WITH WASTE PLASTIC

Name of the adding material: **WASTEPLASTIC**

5.1 COMPACTION TEST

AIM:

To determine the increase in maximum dry density for the soil my mixing the plastic material

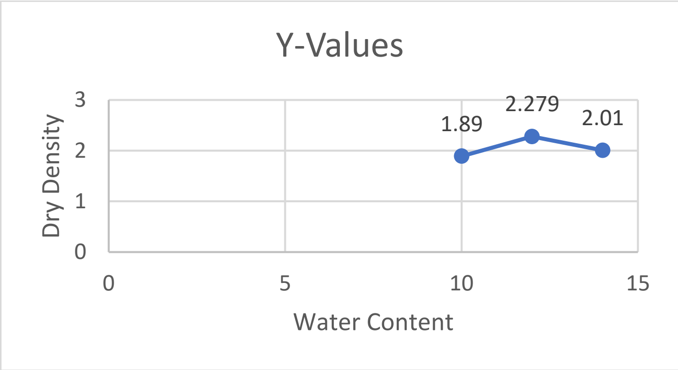
PROCEDURE:

(1).Take a representative oven-dried sample, approximately 2.5 kg in the given pan. Thoroughly mix a sample with sufficient water which is equal to optimum moisture content. (2). Weight the proctor mould without base plate and collar. Fix the collar and base plate. (3). Place the soil in the proctor mould and compact it in three layers giving 25 blows per layer with the 2.5kg rammer falling through. (4). Remove the collar, trim the compact soil even with the top of the mould by means of the straight edge and weight. (5). Divide the weight of the compacted specimen by 990 cc and record the result as the wet weight in grams per cubic of the compacted soil. (6). Remove the sample from mould and slice vertically through and obtain a small sample for moisture determination.

(7). Throughly break up the remaining material in a pan weigh it and place it in an oven to find water content.

S.no	Water content %	Dry density
1	12	2.01
2	12	2.279
3	12	1.89

Graph:



Result:

Maximum dry density for the soil is 1.98gm/cc for reinforced soil at 12% water content.

Maximum dry density for this soil is 2.279gm/cc for reinforced soil with plastic strips at 12% water content.

Therefore increase of density by 15.10% after mixing plastic

5.2 DIRECT SHEAR TEST

AIM: To the shear parameters for the taken soil sample blended with plastic strip

PROCEDURE:

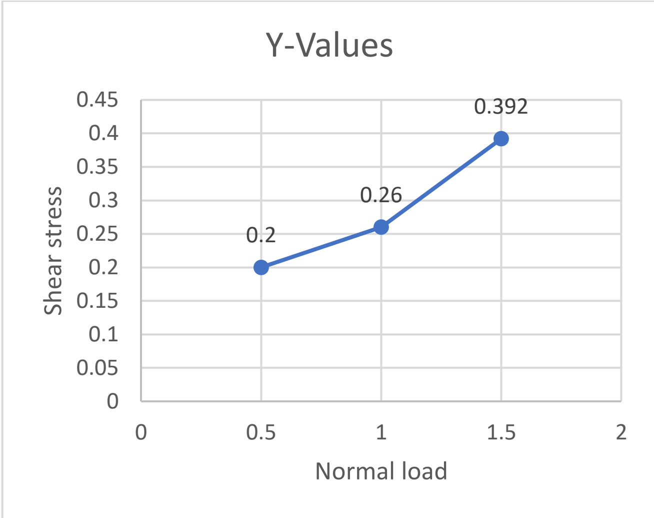
(1).Take a representative oven-dried sample in the given pan. Thoroughly mix a sample with maximum water which is equal to optimum moisture content. (2). The internal dimensions of the shear box are measured. (3). The upper part and lower part are fixed to the box by locking screws attach to the base plate to the lower part. (4). The grid plates are then placed in the shear box keeping their graduations perpendicular to the plane of shear. (5). The shear box along with grid plates, base plates are weighted.

(6). The soil specimen is now placed in shear box if clay are filled if sand up to a depth 15mm from top is lift free then the sample is level. (7). The shear box along with the specimen is weighted. (8). The shear box is now placed on the loading frame and loads are added to the loading pad. (9).The upper half part of the shear box is made in contact with the poring ring. (10).The dial gauge are settled up one is placed to record displacement and another dial gauge to container to record horizontal displacement. (11).Apply a normal stress of 0.25 kn/sq.mt note the readings of the vertical displacement dial gauge.(12). Adjust all the dial gauge to read zero the proving should also zero.

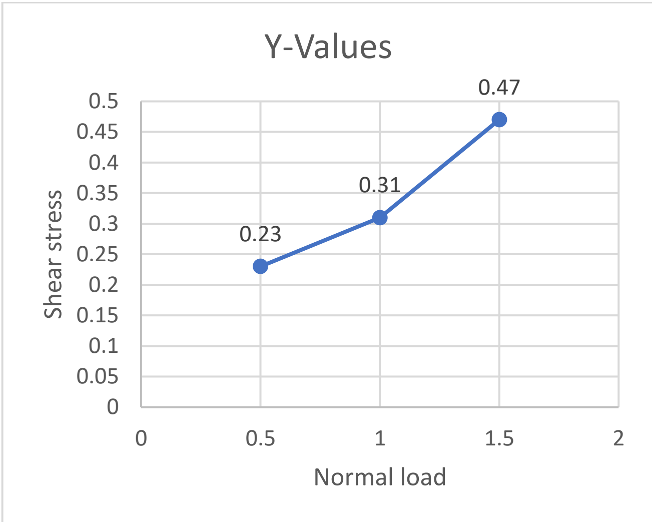
(13). Applying the horizontal shear load at constant rate of strain 0.2mm/min.

(14). Continue the test till the specimen fails (or) till a strain of 20% reached. (15). Repeat the experiment further normal stress on identical specimen.

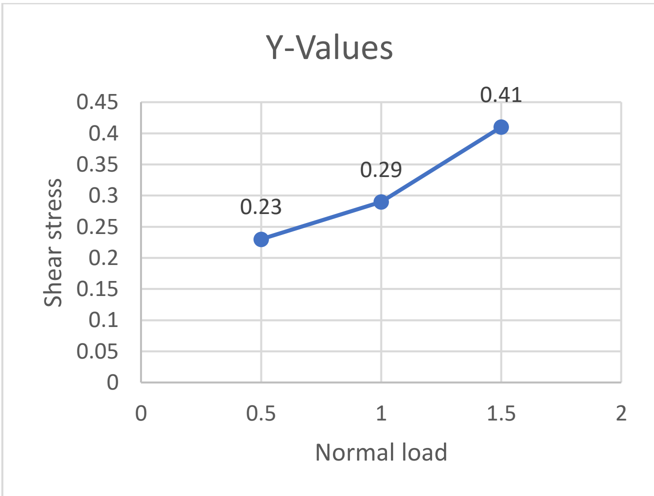
Graph:1



Graph:2



Graph:3



5.3CALIFORNIA BEARING RATIO TEST

AIM: To determine the C.B.R value of the given sample

PROCEDURE:

(1).Take a representative oven-dried sample, approximate 5kg in the given pan. Thoroughly mix a sample with sufficient water which is equal to optimum moisture content.(2).The sample is obtained by collecting material passing through 20mm 1.S sieve about 4.5 kg to 5.5 kg of the material is taken and mixed thoroughly with required water content. (3). The extension collar is now placed upon the mould, also fix the bottom to the base plate.(4). Place a spacer disc at bottom and fill in the soil in layers as mentioned by I.S light compaction test (or) I.S heavy compaction lost. (5). The extension collar is then removed after filling the mould with sample. (6). The are fine to the

S.NO	Penetration guage		Load dial guage	
	Dial guage readings	Penetration (mm)	Dial guage readings	Load (N)
1	0	0.0	30	0.070
2	50	0.5	68	0.159
3	100	1.0	80	0.188
4	150	1.5	152	0.357
5	200	2.0	264	0.62
6	250	2.5	410	0.96
7	300	3.0	494	1.26
8	350	3.5	560	1.137

level of the mould. (7). Looser the base plate and remove the base plate and spacer disk. (8). The mould is now weighed with the compacted soil. (9). Place annular masses like spacer disk with central hole, to produce a surcharge equal to the mass of the base material and wearing cat of the expected pavement. (10). The mould is now placed on the bottom plates of the apparatus. (11). The plunger is adjusted centrally such that it penetrate when load is applied.(12).The plunger should be kept just contact with soil specimen such that penetration occurs applying load. (13). Set the load dial gauge to displacement dial gauge to zero. (14.) The load is applied on the plunger such that the rate of penetration is 1.25mm/min. (15). At the end of the test soil specimen is taken for water content determination. (16). The corresponding dial gauge reading for 2.5mm and 5mm penetration are determined. (17). In general C.B.R is reported as value at 2.5mm penetration. If which is more than that is at 5mm.

TABLE FOR C.B.R REINFORCED WITH PLASTIC 10%

S.NO	Penetration guage		Load dial guage	
	Dial guage readings	Penetration (mm)	Dial guage readings	Load (N)
1	0	0.0	16	0.037
2	50	0.5	20	0.047
3	100	1.0	34	0.079
4	150	1.5	125	0.294
5	200	2.0	225	0.53
6	250	2.5	340	0.80
7	300	3.0	460	1.01
8	350	3.5	540	1.27

Table 5.3.1

C.B.R AT 2.5mm

PENETRATION = (LOAD AT 2.5mm/13.44) ×100

= (0.80/13.44) ×100

= 5.95%.

FOR C.B.R REINFORCED WITH PLASTIC 20%

Table 5.3.2

C.B.R AT 2.5mm

PENETRATION = (LOAD AT 2.5mm/13.44) ×100

(0.96/13.44) ×100 =7.14%

FOR C.B.R REINFORCED WITH PLASTIC 30%

S.NO	Penetration guage		Load dial guage	
	Dial guage readings	Penetration (mm)	Dial guage readings	Load (N)
1	0	0.0	32	0.07
2	50	0.5	76	0.17
3	100	1.0	98	0.23
4	150	1.5	150	0.35
5	200	2.0	242	0.56
6	250	2.5	346	0.81
7	300	3.0	414	1.97
8	350	3.5	501	2.137

C.B.R AT 2.5mm
PENETRATION = (LOAD AT 2.5mm/13.44) ×100
(0.81/13.44) ×100 =6.05%.

REPORTING RESULTS:
There is increase in bearing capacity value by 7.14% at 20% plastic content.

6. CONCLUSION

We obtain partial replacement of soil by waste plastic we obtained maximum shear strength by 20%partial replacement of soil by waste plastic.

Also, for other percentage of partial replacement of soil by waste plastic we find that the shear strength obtained is more than the shear strength of soil without waste plastic.

Thus this project is to meets the challenges of society to reduce the quantities of plastic waste, producing useful material from non-useful waste materials that lead to the foundation of sustainable society.

7.REFERENCE

1. Civil Engineering and Urban Planning: An International Journal (CIVEJ) Vol. 1, No. 1, June 2014.

2. Femeede Muhammed Haneef et al Int. Journal of Engineering Research and Applications ISSN: 2248-9622, Vol.4, Issue 4(Version 1), April 2014, pp. 160-164 Ground change methods, December 18, 2008.

3. International Journal of Engineering Innovation and Research Volume 2 Issue 3 ISSN: 2277-5668 by SW Thakare and SK Somule

4. International Journal of Engineering and Innovative Technology Volume 4 Issue 7 January 2015 by Phani Kumar V.

5. International Journal of Research in Engineering and Technology ISSN: 2321-7308 by V Mallikar june and T Bindu Mani,

6. Journal of Civil Engineering end Environmental Technology Print ISSN: 2349-8404; Online ISSN: 2349 - 879X; Volume 1, Number 6 August, 2014 pp. 1-3 by Aditya Singh Rawat

7. Journal of Engineering and Development, Vol. 17, No.4, October 2013, ISSN 1813-7822 by Maha Hatam Nsaif.

8. Soil Stabilization Using Raw Plastic Bottles, Proceedings of Indian Geotechnical Conference December 15-17, 2011, Kochi (Paper No. H-304) by Mariamma Joseph.

9. Technical for soil adjustment, December 24, 2010,

10. The for soil adjustment, April 9, 2011 by Ana.

11. Achmed Fauzi, et al. "Soil engineering properties improvement by Utilization of cut weste plastic and crushed waste glass as additive", Int. J. of engineering and Technology, Vol. 8, Issue No. 1, pp. 15-18, 2016.

12. Malhotra, et.al. "Effect of HDPE plastic on the unconfined compressive strength of black cotton soil" Int. J. of Innovative Res, in Science Engineering. And Technology, Vol.3, Issue. 1, 2014.

13. Anas Ashraf et.al, "Soil stabilization by using raw plastic bottles" Proceedings of Indien Geotechnicel

Conference", December 15-17,2011, Kocki.