Soil Stabilization Using Plastic Sheets

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***Abstract*- Soil is the key element of this nature and all the basic needs of life such as food, house and cloths are fulfilled by the soil. Black Cotton soils with high potential for swelling and shrinking as a result of change in moisture content are one of the major soil deposits of India. Soil stabilization is the process which improves the physical properties of soil, such as shear strength, bearing capacity which can be done by use of controlled compaction or addition of suitable admixtures like cement, lime, sand, fly ash or by providing geo textiles, geo synthetics etc. The new technique of soil stabilization can be effectively used to meet the challenges of society, to reduce the quantities of waste, producing useful material from non-useful waste materials. Since the use of plastic in diversified forms such as chairs, bottles, polythene bags, etc., has been advancing speedily and its disposal has been a problem all the time regarding the environmental concern, using plastic as soil stabilizer would reduce the problem of disposing the plastic as well as increases the density and California Bearing Ratio (CBR) of soil in an economical way. The present study is focused to overcome the problems experienced in Amaravathi, the capital of newly formed Andhra Pradesh State. In the present study, an experimental program was conducted for stabilization of Black Cotton Soils in the Capital Region ie, Amaravathi of newly formed Andhra Pradesh, with the utilization of Plastic waste as soil stabilizer. Different contents of plastic strips (% by weight varying from 0% to 8%) are added to the Black Cotton Soil and the optimum percentage of plastic strips in soil was found out by conducting California Bearing Ratio Test.**

INTRODUCTION

Soil is the key element of this nature and all the basic needs of life such as food, house and cloths are full filled by the soil. Soil is the thin layer of material covering earth's surface and is formed from the weathering of rocks. Soil is a mixture of organic matter, minerals, gasses, liquid and organisms that together support life. The Earth body of soil is the Pedosphere, which as four important functions; it is the medium for plant growth; it is means of water storage, supply and purification; it is a modifier of at earth atmosphere; it is a habitat for organisms. Soil is a product of influence of climate relief, organisms, and its parent materials interacting over time. It continually undergoes development by way of numerous physical, chemical and biological processes, which include weathering with associated erosion.

Soil Stabilization is any process which improves the physical properties of soil, such as increasing shear strength, bearing capacity, soil gradation, reduction of plasticity index or swelling potential, and increases in durability and strength etc., which can be done by use of controlled compaction or addition of suitable admixtures like cement, lime and waste materials like fly ash, phosphogypsum etc.

NEEDS OF STABILIZATION

1 Improved stiffness and tensile strength of the material.
2 Reduction in pavement thickness.
3 Improved durability and resistance to the effect of water.
4 Reduction in swelling potential.

LITERATURE REVIEW

Dr. Solly George et al. (Apr-2016) conducted a study on soil stabilization using plastic bottle strips. In this present study 0.25%, 0.5%, 1.0% of plastic bottle strips was used to stabilize the red earth soil. The test results indicate that there is increase in the CBR value 4.10 while using 0.5% strips and further addition of plastic bottle strips tend to decrease the value of CBR. It is concluded that, the optimum CBR value is 4.10 at 0.5% of plastic bottle strip.

1.Sharan Veer Singh et al. (Feb-2017) conducted a study on soil stabilization using plastic waste. In this present study 0.5 % of plastic waste for Black cotton soil and 0.7% of plastic waste for Red soil. The test indicated that there is increase in the CBR value of 3.3 for Black cotton soil and 2.94 for Red soil.

2. V.Mallikarjuna et al. (May-2016) conducted a study on soil stabilization using plastic waste (Polypropylene). In this present study 2%, 4%, 6% and 8% for black cotton soil. The test results are for CBR value are 2.02, 11.7, 4.8 and 4.0.and obtained MDD and OMC test values are1.75g/cc and 19%, 1.81g/cc and 18.5%, 1.71g/cc and 18.0%, 1.65g/cc and 17.4%. It is concluded that 4%plastic content is the OPTIMUM CONTENT of utilization of plastic waste in the soil.

3. Shiva Kumar. K. et al. (May-2016) conducted a study on soil stabilization using waste plastic strips. In this present study 0.05%, 0.1%, 0.15% and 0.2%plastic strips are added to black cotton soil. The test results are for CBR value 2.5mm penetration the value is 3.5%, 9.48%, 9.44%, 9.920% and for 5mm penetration value is 3.06%, 3.26%, 9.24%, 9.28%, 9.88% . MDD and OMC test results are 1.64g/cc, 1.695g/cc, 1.68g/cc,1.68g/cc, 1.65g/cc and 24.6% , 22%, 23%, 24.5%, 25% plastic waste added 0.05%, 0.1%, 0.15%, 0.2%.It is concluded that OPTIMUM CONTENT of CBR value for 9.92% at 2.5mm penetration and 9.88% at 5mm penetration. The maximum MDD and OMC value is 1.68g/cc and 24.5%.

M. Veena et al. (Dec-2011) conducted a study on soil stabilization using raw plastic bottles. In this present study 0.0%, 0.2%, 0.4%, 0.6%, 0.8%, 1.0% of plastic content are added. The test results are for CBR value 1.9g/cc, 1.7g/cc, 1.8g/cc, 2.5g/cc, 1.3g/cc,
of virgin soil. 1.3g/cc. The plate load test results are at o% of PW it consist plane soil , 0.2% of PW it consist sand filled bottles at D/B=0.67,0.4% of PW consist sand filled bottles at D/B=1,0.6% Of PW it consist bottles cut to halves at D/B =0.67, 0.8% of PW it consist of bottle cut to halves at D/B=1, 1.0% of PW it consist OPTIMUM % of plastic strip. It is concluded that for soil mixed with waste plastic strips, soaked CBR values increased from 1.967 to 2.479 with 0.6% of plastic and there after decrease.

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 that addition of waste plastic strip of appropriate size and proportion in soil result in increase in both CBR value and secant modules of soil.

Bala Ramudu Paramkusam et.at. (2013)performed an experimental study to investigate the stabilization effect of waste plastic on dry density and CBR behavior of red mud, Fly ash mixed with different percentage of waste plastic (PET) content. Based on light compaction tests, authors concluded that MDD value of the red mud, fly ash mixed with plastic increases as the waste plastic increase till 2%, further increase in plastic waste reduce the MDD value. OMC value remains same in each case. A marked increase in CBR value was also observed on adding 0.5%, 1.0%, 2.0%, of plastic and was found to be decreased after inclusion of 3% and 4% increase of CBR value that the thickness of pavement can be reduced by addition of waste plastic content up to 2%

Subhash,K. et.al. (2016) conducted experimental study on soil stabilization using glass and plastic granules mixed with varing percentage. Modified Proctor tests were carried out to study OMC and CBR. They concluded that there is decrease in MDD on addition of glass and plastic in varying percentages. The MDD of 1.53g/cc was obtained at 6% of glass and plastic.The maximum OMC was obtained as 22.6% at 6% mixing of additive. Further, an increase in the OMC was observed, maximum value of OMC was obtained as 22.6% at 6% glass and plastic additive with the soil. An increase in the UCS from 0.609kg/cm^2 to 3.023kg/cm^2 which is about 5 times as that of virgin soil. Maximum CBR value was 7.14%, which is 2 times of CBR

Yashwanth Sagar.T.K. conducted a study on plastic as a soil stabilizer. In this present study 0%,0.2%,0.4%,0.6%,0.8%,1%, plastic was used to stabilize the laterite soil. The test results indicate that there is increase in the CBR value 1.9,1.7,1.8,2.5,1.3,1.3, it is conclude that the optimum CBR value is 2.5 at 0.6% of plastic waste and MDD 19kN/m^3 at 11% of water content

OBJECTIVES

The objectives of this case study as follows:

1 To increase the Density and CBR of soil using plastic as an admixture.
2 To provide an economical relation for soil stabilization using plastic waste.

3 To determine the alternative solution for the disposal of Plastic waste.

Increase in the CBR value is meant for the mechanical strength of natural ground subgrade and base courses beneath the new carriage construction and increase the load bearing capacity.

Recycling can help to reduce the amount of garbage that ends up in land fields, water ways and eco system, only a few types of plastic can be recycled by most municipal government

MATERIALS AND METHODOLOGY

The major materials which have been used in the experimental investigation include:

1 Soil - Soil samples collected from our college campus for their geotechnical properties and strength characteristics.

2 Plastics polythene sheet, which are of uniform size and shape collected from fertilizer stores.

STUDY METHODOLOGY

In this project an attempt is made to find the best locally available material which satisfy the design and strength criteria of subgrade soils. Following steps are followed during this study.

1 Collection of soil sample and plastic fibre.

2 Geotechnical tests were conducted for the soil samples collected. The tests are Specific gravity test , Grain size analysis, Atterberg's limit test, Standard Proctor tests, California Bearing Ratio (Soaked & Un soaked),Unconfined Compressive test.

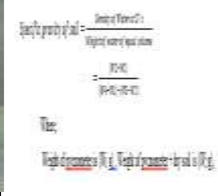
3 Laterite soil is stabilized by adding plastic material layer wise, then the properties are determined by conducting Atterberg tests, Proctor test, UCC and CBR tests.

GEOTECHNICAL PROPERTIES OF SOIL

Following are the tests conducted to determine basic properties of laterite soil.

Specific Gravity: The IS :2720 (Part III) deals with the method of test for determination of specific gravity of soils which finds application in finding out the degree of saturation and unit weight of soils. The unit weights are needed in pressure, settlement and stability problems in soil engineering. The fig shows Pycnometer which is used to determine specific gravity.

Fig 4.1: Pycnometer



SAND	2.64 – 2.67
SILT	2.68 – 2.7
CLAY	2.7 – 2.8
ORGANIC SOIL	1.26 – 2.6

Table 1.1 specific gravity

PROCEDURE

1. Dry the pycnometer thoroughly and weight (w_1) it with its cap tightly screwed on.
2. Unscrew the cap and put in about 200 gm of oven dried soil passing 4.75mm I.S. Sieve and weight (w_2) again.
3. Add sufficient water to cover the soil about half full and screw on the cap.
4. Shake well and connect to the vacuum pump to remove entrapped air. Allow the air to be evacuated for 10 minutes and then remove vacuum pump.
5. Then fill the pycnometer with water about three fourth full and again vacuum pump is applied to evacuation of air for 5 minutes.
6. After the air has been eliminated, fill the pycnometer with water completely upto the mark and dry it from the outside and then weigh (w_3).
7. Clean the pycnometer by water thoroughly and fill it with water upto its top and weigh (w_4).
8. Repeat the same process for 2 to 3 times, to take the average reading of it.

Weight of pycnometer + dry soil + water at temperature T ^{0}C is (W_3 g), Weight of pycnometer + water at temperature T ^{0}C is (W_4 g) and Specific gravity G at 27^0 C

Particle Size Distribution: The Standard grain size analysis test determines the relative proportions of different grain sizes in the soil. The percentage of gravel, sand, silt and clay are known by plotting the graph. The results were discussed in Chapter 4.

Gravels and sands may be either poorly graded (Uniformly graded) or well graded depending on the value of coefficient of curvature and uniformity coefficient.

Boulder> 300 mm,Cobble< 300mm and > 80mm, Gravel (G)< 80mm and > 4.75mm, Coarse gravel = 80mm to 20mm, Fine gravels = 20mm to 4.75mm.
Sand (S)< 4.75mm and >0.075mm.
Coarse sand = 4.75mm to 2mm, Medium sand= 2mm to 425µ, Fine sand = 425µ to 75µ.
Silt> 75µ and < 2µ and Clay< 2µ.

PROCEDURE:

1. A known weight (500gm) of representative sample of given soil (Oven dried) is taken.
2. The sieves are arranged one above the other in the ascending order with a pan at the bottom (75□, 150□, 250□, 425□, 600□, 1mm, 2mm, and 4.75mm). The soil sample is placed on the top.
3. The set of sieves with soil is fitted to a mechanical sieve shaker and sieving in done for at least 10 minutes.
4. The soil fraction retained on each sieve is collected carefully and its weight is noted accurate to 0.1 gm.
5. The sum of weights retained should be equal to 500gm. If it is not equal to 500gm., the error (always -ve) is distributed proportionately.

Coefficient of curvature (Cc) and Uniformity coefficient (Cu) are estimated as:

$$C_c = \frac{{D_{30}}^2}{D_{10} \times D_{60}} \quad \& \quad C_u = \frac{D_{60}}{D_{10}}$$

Where,
D_{60} = particle size at 60% finer. D_{30} = particle size at 30% finer and
D_{10} = particle size at 10% finer.
Coefficient of curvature (Cc) should lie between 1 and 3 for well grade soil. Uniformity coefficient (Cu) value should be more than 4 for well graded gravel and more than 6 for well graded sand.

GRAPH:
Draw graph between log sieve size v/s % finer (Semi log sheets). The graph is known as grading curve. Corresponding to 10%, 30% and 60% finer, obtain diameters from graph are designated as D_{10}, D_{30}, D_{60}.

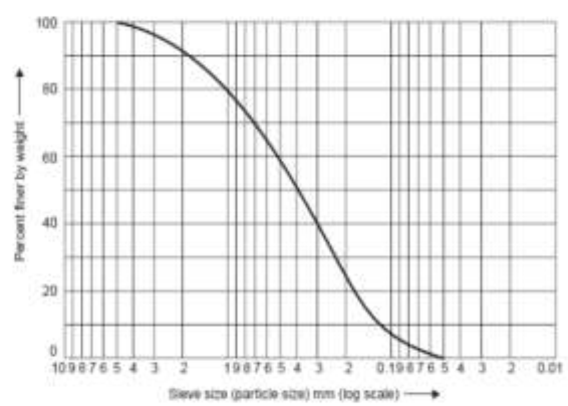


Fig: Typical grain size distribution curve


Fig 4.4.1: .Casagrande’s Liquid Limit Device

Moisture content: A soil is an aggregate of soil particles having a porous structure. The pores may have water and air. The pores are also known as voids. If voids are filled with water, the soil is called saturated soil and if voids have only air, the soil is called dry. Moisture content is defined as the ratio of the mass/weight of water to the mass/weight of solids. For moist content determination soil samples are dried to the temperature at which only pore water is evaporated. This tempe

PROCEDURE:
1. The container is cleaned and it is weighed (W1)
2. The required quantity of most soil sample is put into the container & the lid is closed tight until the weight is taken (W2)
3. The lid is removed & the container is kept in the oven for about 16 to 24 hours at a temperature between 105o c & 110oc
4. The container is removed from the oven & the lid is closed tight. It is cooled for some time and the weight is noted (W3)

5. The steps 1 to 4 are repeated with two more samples of same soil and the average water content is found out.

Moisture was standardized 105oC to 110oC. Soils having gypsum are dried at 60o to 80oC.

Consistency Limit Tests Consistency limit tests were conducted for laterite soil

Casagrande's liquid limit test: Casagrande method was adopted to determine the liquid limit of soil as per IS: 2720 (Part 5) –1985. The liquid limit of fine-grained soil is the water content more than which soil be haves practically like a liquid, but has small shear strength. Liquid limit is the water content corresponding to 25no. of blows as per Casagrande's method. The results were discussed in Chapter 5 and equipment is as shown in Fig.

PROCEDURE:

1. Adjust the Casagrande's apparatus for a correct fall of 1 cm using the adjustment Gauge block & adjustment screws.
2. About 120gm. of soil passing through 425 micron sieve is taken and is mixed with sufficient water until it becomes a uniform paste.
3. The brass cup of Casagrande's apparatus is filled with the soil paste & is made level with spatula. The soil surface should be such that it is parallel to the base, when the cup is resting on the base and maximum thickness of soil should be1cm.
4. Using the Casagrande's grooving tool a V-shaped groove is made in the soil keeping the tool perpendicular to the cup surface.
5. The handle is turned (manually or by motor) at a rate of 2 revolutions/sec, until the groove is closed for a length of 10 mm. & the number of revolutions or blows are noted.
6. Taking a sample from the cup where two grooved soil joins, the water content is determined.
7. The water content of the remaining soil is increased & the steps 3 to 6 are repeated to get readings in the range of 10 to 40 blows.

Cone penetration test: To determine the liquid limit of given soil sample by using cone penetration method. By the cone penetration method, LL of a soil is determined as the water content in the soil sample when the depth of the penetration of the standard cone is 20mm. The depths up to which the standard metal cone penetrates into samples of soil paste prepared with different water contents in five seconds are measured.

PROCEDURE: About 150g of soil sample is mixed in a dish to form a paste and is transferred into cylindrical cup of the cone penetrometer apparatus and is levelled without entrapped air.

1. The cone is adjusted to just touch the surface of the soil paste and is clamped and the initial reading is noted.
2. The clamp is released allowing the cone to penetrate into the soil paste under its self-weight for five seconds and the final penetration reading is noted.
3. The cone penetration value in mm is the difference between the final and initial penetration readings in a period of 5 second.
4. The test is repeated four to five times with different water contents in the soil paste so that the penetration values are between 14 and 28mm. the values of water content in the soil paste in each test is determined by taking a portion of the test sample and determining the weights in wet condition and after drying in the oven.

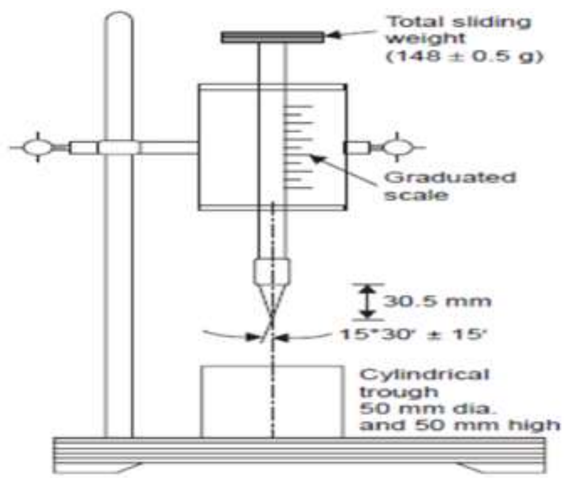


Fig 4.4.2: Cone Penetrometer

Plastic Limit Test: Plastic limit is defined as minimum water content at which soil remains in plastic state. Fig. 3.5 shows plastic limits test samples. The results are discussed in Chapter 4.

PROCEDURE: Take about 30g of air dried sample passing 425 sieve.

It is mixed thoroughly with enough water, so that it can be shaped into a ball.

Take about 10g of the plastic soil mass and roll it between the hand and the glass plate to form the soil mass into a thread. If diameter of thread becomes less than 3mm without cracks, it shows that water added in the soil is more than its plastic limit. Hence the soil is kneaded further and rolled into thread again.

Repeat this rolling and remolding process until the thread starts just crumbling at a diameter of 3mm.

Collect the piece of crumbled soil thread at 3mm diameter in air tight container and determine moisture content. Repeat the procedure more times with fresh soil.

	
Fig 4.4.3: Plastic Limits Test Sample	Fig4.2.6: Compaction Test Moulds and Rammers

IN SITU DENSITY TEST: Core cutter method: PROCEDURE

SAND REPLACEMENT METHOD

PROCEDURE:

(a) Determination of weight of sand filling the cone.

1. The sand pouring cylinder is filled nearly full with standard sand and it is weighed accurate to 1 gm. (W_1)
   Note: This weight should be maintained constant throughout.
2. The S.P Cylinder is then placed on the glass plate & sand is allowed to fill the cone by opening the shutter. The shutter is closed when no movement of sand is observed in the cylinder. The S.P cylinder is weighed with the remaining sand (W_2).

(b) Determination of bulk density of standard sand.

1. The internal volume (V) of the calibrating container is calculated by measuring its internal dimensions.
1. The S.P cylinder with sand as in step 1 (W_1) is placed concentrically over calibrating container. The shutter is opened & sand is allowed to fill the container & the cone. The shutter is closed when no movement of sand is observed.
2. The weight of S.P cylinder with the remaining sand is noted (W_3)
3. The step 4 is repeated two more times & the mean weight W_3 is taken

(c) Determination of in-situ density of soil.

1. About 45 cm. Square areas in the field are cleaned of surface debris & grass and it is made level. The tray is kept on this level surface and a circular hole of about 10cm diameter is excavated upto about 15cm depth. The excavated soil collected in the tray is weighed (W_{soil}).
2. The tray is removed from the site and sand pouring cylinder with constant weight of sand (W_1) is placed concentrically over the hole. The shutter is opened and sand is allowed to fill the hole & the cone completely. The S.P cylinder with remaining sand is weighed (W_4)
3. Representative samples of excavated soil are kept in containers for water content determination.

Compaction Tests: Both Standard compact test and modified compact tests were conducted for natural laterite soil. About 3000g of oven dry soil was passed through the 20mm sieve were compacted by using rammer. Weigh the mould with the sample and recorded on data sheet. Small quantity of soil sample was taken for determining moisture content.

V = Volume of mould.

The dry density of the soil shall be calculated as follows

$\gamma_d = \frac{\gamma_b}{1+w}$

Where, γ_b = wet density of the compacted soil

w = moisture content

The results are discussed in Chapter 4.

California Bearing Ratio Test : Using the natural soil OMC and ODD are determined and using corresponding dry density the amount of soil required for CBR was calculated. The soil specimen was filled in mould and the surcharge weight is placed in position on top of soil sample. The samples are tested under the loading condition for unsoaked and soaked condition. The load for 2.5mm and 5mm penetration are recorded and corresponding 2.5mm penetration CBR is noted.

Fig 4.2.7: CBR Testing Machine

Fig 4.2.8 : Unconfined compressive strength test

Unconfined Compressive Strength Test: The primary purpose of this test is to determine the unconfined compressive strength, which is then used to calculate the unconsolidated untrained shear strength of the clay under unconfined conditions. According to the IS standard, the unconfined compressive strength is defined as the compressive stress at which an unconfined cylindrical specimen of soil will fail in a simple.

RESULT AND DISCUSSION

BOTTOM SOIL TEST

SL NO	DESCRIPTION	TRIAL-1	TRIAL-2	TRIAL-3
1	Weight of Pycnometer (W1) g	460	470	470
2	Weight of Pycnometer + dry soil (W2) g	710	720	770
3	Weight of Pycnometer + dry soil + water (W3) g	1390	1400	1425
4	Weight of Pycnometer + Water (W4) g	1250	1255	1260

PYCNOMETER METHOD

Specific gravity of soil

$$= \frac{Density\ of\ water\ at\ 27\ c}{Weight\ of\ water\ of\ equal\ volume}$$

$$= \frac{(W2-W1)}{(W4-W1)-(W3-W4)}$$

RESULTS-Specific gravity of soil by pycnometer method =2.3

1. DENSITY BOTTLE METHOD

2. MOISTURE CONTENT

SL NO	DESCRIPTION	TRIAL-1	TRIAL-2
1	Weight of density bottle (W1) g	25	25
2	Weight of density bottle + dry soil (W2) g	60	70
3	Weight of density bottle + dry soil + water (W3) g	200	205
4	Weight of density bottle + water (W4) g	180	180

SL.NO	DESCRIPTION	TRIAL-1	TRIAL-2
1.	Weight of container empty (W1) g	10	10
2.	Weight of container + wet soil (W2)g	24.980	23.460
3.	Weight of container + dry soil (W3)g	18.290	17.760
4.	Weight of water, Ww =(W2-W3)	6.69	5.7
5.	Weight of dry soil, Wa=(W3-W1)	8.29	7.76
6.	Moisture content $w = \frac{Ww}{Wd}$	80.70	73.45

TOTAL AVERAGE =2.3

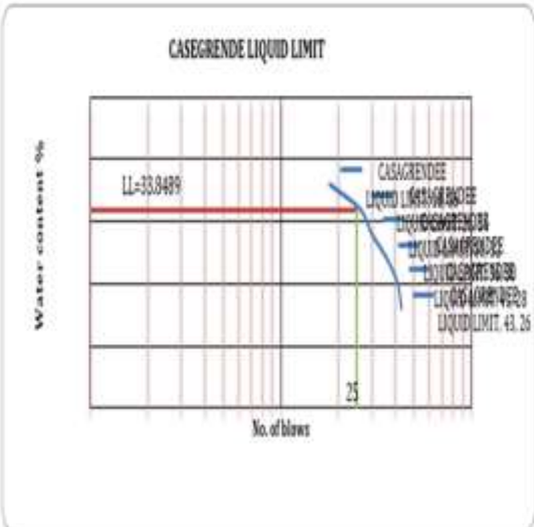
RESULT- Specific gravity of soil by density bottle method=2.3

RESULT- Moisture content of soil=77%

CONSISTANCY LIMITS

1.1 CASAGRANDES METHOD

No of blows	43	41	36	30	26	18
Moisture content determination	26%	28%	30%	32%	34%	36%
Weight of container (W1)	10	10	10	10	10	10
Weight of container + wet soil (W2)	20	20	20	20	20	20
Weight of container + dry soil (W3)	17.42	17.56	18.01	18.38	19.02	19.42
Moisture content (w) $w = \frac{Ww}{Wd}$	34.77	32.28	24.84	19.33	10.87	6.16



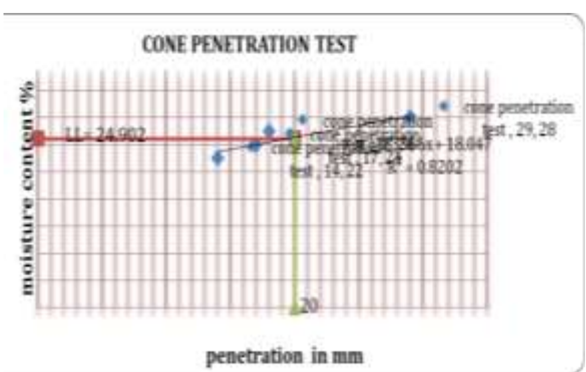
Graph -1 Casegrende's liquid limits

Graph -1 Casegrende's liquid limits

RESULT- Liquid limit of the soil =33.8489%

CONE PENETRATION TEST

SL NO.	DESCRIPTION		TRAIL I	TRAIL II	TRAIL III	TRAIL IV
	Water added in %		22	24	26	28
1	Penetration Reading	initial	18	18	19	10
		final	32	35	37	39
		Difference	14	17	18	*29*
	MOISTURE CONTENT					
1	Container no.		1	2	3	4
2	Wt. of container (W1)		10	10	10	10
3	Wt. of container + wet soil (W2)		20	20	20	20
4	Wt. of container + dry soil (W3)		17.68	16.42	16.47	16.53
5	Moisture content $w = \frac{Ww}{Wd}$		30.21	55.76	54.56	53.14



Graph -2: Cone penetration test

RESULT – Liquid limit of soil =24.902%

PLASTIC LIMITS DESCRIPTION	TRAIL I	TRAIL II	TRAIL III	TRAIL IV
Wt. of container(W1)	4.41	4.41	4.41	4.41
of container + wet soil (W2)	5.54	5.94	6.10	6.42
Jkkk				
Wt. of container + dry soil (w3)	5.36	5.63	5.64	5.72
Moisture content (w), $w = \frac{Ww}{Wd}$	18.94	25.41	37.40	5344

GRAIN SIZE ANALYSIS

SL NO	IS SIEVE	PARTICAL SIZE mm	Wt. RETAINED	%Wt. RETAINED	CUMMULATIVE	% FINER
1	4.75	4.75	240	24	24	76
2	2.36	2.36	90	9	33	67
3	1.18	1.18	210	21	54	46
4	600	600	150	15	69	31
5	425	425	70	7	76	24
6	300	300	70	7	83	17
7	212	212	65	6.5	89.5	10.5
8	150	150	30	3	92.5	7.5
9	75	75	10	1	93.5	6.5
10	Pan	Pan	30	3	96.5	3.5

Average of plastic limit is 33.80% , Plastic index = (WL –WP)= 1.2%,

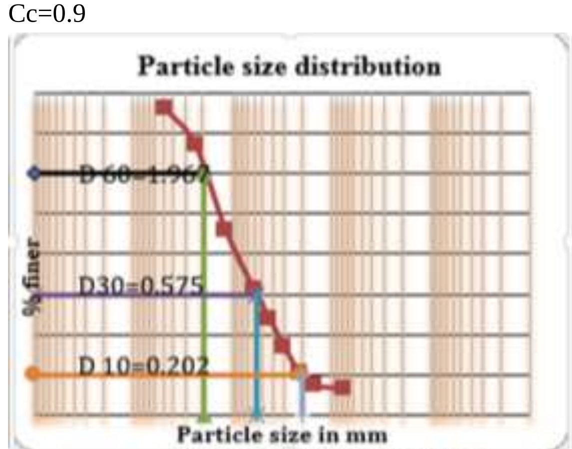
RESULT – plastic limit = 33.08% , Plastic index = 1.2%

$\sum w=96.5$

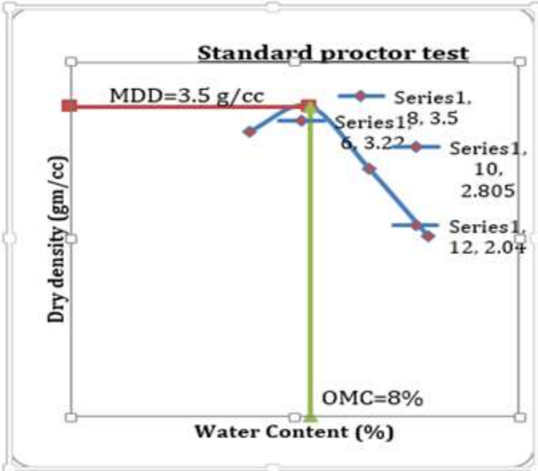
1) $Cu = \frac{D60}{D10}$ 2) $Cc=\frac{(D30)^2}{D60*D10}$

$Cu = \frac{1.9}{0.18}$ $Cc=\frac{(0.57)^2}{(1.9*018)}$

Cc=0.9



Graph-3: Grains size analysis



Graph 4: Standard proctor test

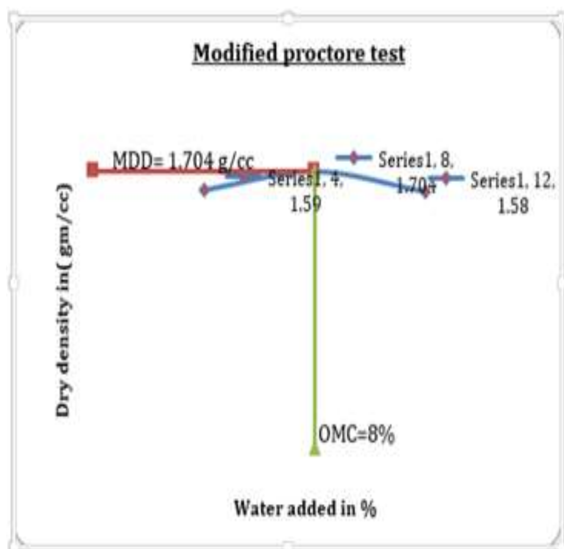
STANDARD PROCTOR TEST

SL NO.	DESCRIPTIONS	TRAIL I	TRAIL II	TRAIL III	TRAIL IV
1.	Water added in %	6%	8%	10%	12%
2.	Empty wt. of mould (W1)	2180	2180	2180	2180
3.	Wt. of mould +wet soil (W2)	5610	5776	5770	5590
4.	Bulk density $\sqrt{b} = \frac{(W2-W1)}{V}$	3.43	3.58	3.51	3.40
	MOISTURE CONTENT				
6.	Wt. of container (w1)	10	10	10	10
7.	Wt. of container + wet soil (w2)	15	15	20	15
8.	Wt. of container + dry soil (w3)	14.7	14.9	18	13
9.	Moisture content (w) $w = \frac{ww}{wd}$	6.33	2.0	25	66.67
10.	Dry density$\sqrt{d} = \frac{\sqrt{b}}{(1+w)}$	3.22	3.5	2.805	2.04

RESULT- Maximum dry density= 3.5g/cc
Maximum moisture content= 8%

MOIDIFIED PROCTOR TEST

SL NO.	DESCREPTION	TRAIL I	TRAIL II	TRAIL III
1.	Water added in %	4%	8%	12%
2.	Wt. of empty mould (W1)	5825	5825	5825
3.	Wt. of mould + wet soil (W2)	10510	10540	10320
4.	Bulk density $\sqrt{b} = \frac{W}{V}$	2.12	2.13	2.03
	Moisture content			
5.	Wt. Of container (w1)	10	10	10
6.	Wt. of container + wet soil (w2)	12	15	20
7.	Wt. of container + dry soil (w3)	11.5	14	1.8
8.	Moisture content $w = \frac{Ww}{Wd}$	33.33	25	28.20
9.	Dry density $\sqrt{}= \frac{\sqrt{b}}{(1+w)}$	1.59	1.704	1.58



Graph 5: Modified proctor test

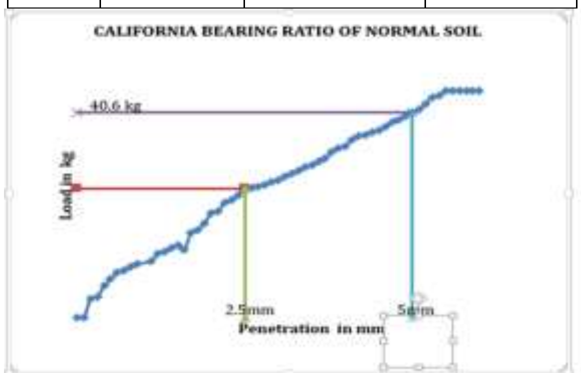
RESULT- Maximum dry density = 1.704 g/cc
Maximum moisture content= 8%

FIELD DENSITY TEST , CORE CUTTER TEST-

14.1 CALIFORNIA BEARING RATIO TEST ON NORMAL SOIL

SL NO.	DESCRIPTION	Normal soil without compaction	Normal soil with compaction	Compaction of soil with plastic			
1	Empty wt. of core cutter(W1)	985	1015	1015			
2.	Wt. of core cutter + wet soil (W2)	2985	3040	3280			
3.	Mass of wet soil (W)	2000	2025	2065			
	Moisture content	T B	T B	T B			
4.	Empty wt. of container (w1)	10	10	10	10	10	10
5.	Wt. of container +wet soil (w2)	15	15	20	20	20	20
6.	Et. of container +dry soil (w3)	14	13.5	19	19	20	18.5
7.	Moisture content $w = \frac{Ww}{Wd}$	33.93	11.11	17.6			
8.	Bulk density $\sqrt{}= \frac{W}{V}$	1.960	2.023	2.300			
9.	Dry density $\sqrt{}= \frac{\sqrt{b}}{(1+w)}$	1.47	1.82	1.86			

Sl. No	Penetration, mm	Proving ring dial reading	Load on plunger, kg
1	0.0	0	0
2	0.01	0	0
3	0.02	11.56	3.8
4	0.03	12.57	4.1
5	0.04	19.34	6.3
6	0.05	23.31	7.6
7	0.06	27.30	8.9
8	0.07	28.53	9.3
9	0.08	30.99	10.1
10	0.09	32.80	10.7
11	0.10	34.36	11.2
12	0.11	38.96	12.7
13	0.12	39.88	13
14	0.13	42.64	13.9
15	0.14	43.87	14.3
16	0.15	41.10	13.4
17	0.16	51.53	16.8
18	0.17	53.37	17.4
19	0.18	57.36	18.7
20	0.19	63.50	20.7
21	0.2	64.42	21
22	0.21	69.94	22.8
23	0.22	71.47	23.3
24	0.23	74.23	24.2
25	0.24	78.22	25.5
26	0.25	78.83	25.7
27	0.26	79.45	25.9
28	0.27	80.37	26.2
29	0.28	83.44	27.2
30	0.29	85.58	27.9
31	0.3	87.73	28.6
32	0.31	89.11	29.05
33	0.32	92.64	30.2
34	0.33	94.79	30.9
35	0.34	96.63	31.5
36	0.35	100.61	32.8
37	0.36	102.76	33.5
38	0.37	103.99	33.9
39	0.38	107.98	35.2
40	0.39	110.12	35.9
41	0.4	110.89	36.15
42	0.41	112.88	36.8
43	0.42	113.80	37.1
44	0.43	115.95	37.8
45	0.44	118.71	38.7
46	0.45	120.25	39.2
47	0.46	122.05	39.8
48	0.47	124.54	40.6
49	0.48	126.38	41.2
50	0.49	129.75	42.3
51	0.5	133.74	43.6
52	0.51	134.66	43.9
53	0.52	137.73	44.9
54	0.53	137.73	44.9
55	0.54	137.73	44.9
56	0.55	137.73	44.9



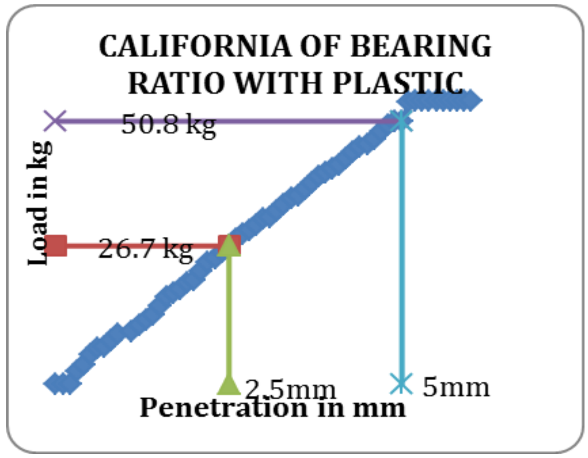
CBR for 2.5mm $= \frac{Test\ load}{standard\ load} = \frac{25.5}{1370}$ =1.86

$CBR\ for\ 5mm = \frac{26.7}{2055} = 1.95$

Sl. No	Penetration, mm	Proving ring dial reading	Load on plunger, kg
1	0.0	0	0
2	0.01	0	0
3	0.02	0	0
4	0.03	7.6	2.5
5	0.04	11.66	3.8
6	0.05	17.79	5.8
7	0.06	21.17	6.9
8	0.07	22.09	7.2
9	0.08	25.77	8.4
10	0.09	29.45	9.6
11	0.10	31.29	10.2
12	0.11	35.28	11.5
13	0.12	38.04	12.4

14	0.13	41.10	13.4
15	0.14	46.63	15.2
16	0.15	51.53	16.8
17	0.16	53.68	17.5
18	0.17	56.13	18.3
19	0.18	59.82	19.5
20	0.19	61.66	20.1
21	0.2	67.18	21.9
22	0.21	72.09	23.5
23	0.22	74.54	24.3
24	0.23	78.22	25.5
25	0.24	81.90	26.7
26	0.25	85.58	27.9
27	0.26	89.26	29.1
28	0.27	91.41	29.8
29	0.28	94.17	30.70
30	0.29	97.85	31.9
31	0.3	99.08	32.3
32	0.31	100.92	32.9
33	0.32	102.45	33.4
34	0.33	106.44	34.7
35	0.34	109.82	35.8
36	0.35	111.96	36.5
37	0.36	115.34	37.6
38	0.37	119.33	38.9
39	0.38	123.01	40.1
40	0.39	125.15	40.8
41	0.4	127.61	41.6
42	0.41	130.06	42.4
43	0.42	133.74	43.6
44	0.43	137.42	44.8
45	0.44	140.80	45.9
46	0.45	142.33	46.4
47	0.46	148.47	47.4
48	0.47	153.68	48.7
49	0.48	158.59	50.1
50	0.49	162.27	51.7
51	0.5	166.87	52.9
52	0.51	168.87	54.4
53	0.52	168.87	54.7
54	0.53	168.87	54.7
55	0.54	168.87	54.7
56	0.55	168.87	54.7

14.2 CALIFORNIA BEARING RATIO TEST ON PLASTIC



Graph 10: California bearing test on plastic

CBR for 2.5mm $= \frac{Test\ load}{standard\ load} = \frac{26.7}{1370}$=1.95

$CBR\ for\ 5mm\ = \frac{50.8}{2055}$ = 2.47

Table 4.1 Geotechnical Properties of Soil Sample

Test Properties		Normal soil without compaction		Normal soil with compaction	Compaction of soil with plastic	Black cotton soil with compaction	IS code for tests
Specific Gravity	Pycnometer Method	2.4		-	-	-	IS:2720 (Part 3)-1980
	Density bottle method	2.3		-	-	-	
Grain size analysis	Uniform co efficient (Cu)	10.56		-	-	-	IS:2720 (Part 4)-1985
	Co efficient of curvature (Cc)	0.65		-	-	-	
Liquid Limit (%)	Casagrende's s method	35%		-	-	-	IS:2720 (Part 5)-1985
	Cone penetration method	30%		-	-	-	
Plastic Limit (%)		33.33%		-	-	-	IS:2720 (Part 5)-1985
Compaction test		MDD (g/cc)	OMC%				
	Standard proctor test	3.5	8				
	Modified proctor test	1.704	8				
Insitu density test (g/cc)	Core cutter method	1.47		1.82	1.86	1.348	IS:2720 (Part 8)-1980
	Sand replacement method	2.206		1.905	2.38	1.22	IS:2720 (Part 8)-1980
Unconfined Compression Strength (KN/m²)		40.25		-	-	-	IS:2720 (Part 10)-1991
CBR Test	2.5 mm	1.86				1.95	
	5mm	1.98				2.47	

CONCLUSION

1 Waste plastic products is increasing day by day, the disposal of plastic waste without causing ecological hazards. Thus using plastic strips is economical and gain full utilization.
2 After adding plastic into the soil, there as been a positive impact on properties of soil.
3 Plastic can be used as soil stabilizers.
4 Unconfined compressive strength of laterite soil is increased due to inclusion of plastic waste.

5 The CBR values are increasing with adding of plastic waste.

FUTURE ENHANCEMENT

1. Different types of plastic can be used.
2. Different types stabilizers can be used.
3. Plastic can be used in percentage wise.
4. Inclusion of plastics can be checked for different types of soil.

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