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Stabilization of Subgrade by Using Waste Plastic Bottle Strips and Marble Dust Powder

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ABSTRACT: The main objective of this study is to provide proper disposal to plastic waste (PET) and to achieve the long time stabilized soil and study of investigation of plastic strips and marble dust powder (MDP) in geotechnical application on optimum moisture content and maximum dry density of black cotton soil (BCS) before and after application of stabilizer. And also the study of effect on CBR value i.e. soaks and unsoaks of soil by the application of PET and MDP and also the changes in compressive strength and share strength of soil. In this study Specific Gravity of Soil By Pycnometer Method, Atterberg Limit Determination, Proctor Density Test, California Bearing Ratio Test and Unconfined Compressive Test are performed with relevant IS code.

KEYWORDS: Soil Stabilization, Black Cotton Soil, Plastic Waste, PET, Atterberg limit, Pycnometer, OMC, MDD, CBR, Unconfined Compressive Strength.

I. INTRODUCTION

Black cotton soil (BCS) is nothing but in-organic clay which has high Compressibility and highly problematical for civil engineering works due to high degree of Swelling and Shrinkage. It also called as Expansion Soil and it has very Low Bearing Capacity. Because these effects of black cotton soil it become challenge for geotechnical engineers and highway engineer. The black colour in this expansion soil should be obtained from presence of Titanium oxide. This soil is very good or ideal for cultivation but the enemy for civil engineering field. This type of expansion soil is mainly found in region of Deccan trap in Indian. To counter out this problem and overcome from the drawback of black cotton soil the special treatment requires is called as soil stabilization .simply, soil stabilization is defined as the process of improving the overall all engineering performance of soil, is called as soil stabilization. in this study the comparatively study of treated and untreated soil is done by performing test as Sp. Gravity of Soil By Pycnometer Method, Atterberg Limit Determination, Proctor Density Test, California Bearing Ratio Test and Unconfined Compressive Test are performed with relevant IS code by applying optimum percentage of plastic (PET) with 5% of MDP as a bounding agent between soil and plastic (as per standard or previous study) because the main aim of this project is to dispose of plastic as a permanent solution for soil stabilization with economically. Due to this stabilization of soil is obtain for long time

II. RELATED WORK

V. Mallikarjuna et al. [1] Studied on the Soil Stabilization Using Plastic Waste soil stabilization by only the single stabilizer as plastic in the form of strips from chain industries of density 0.42gm/cc used to improve the bearing capacity of soil, to define maximum dry density of soil at relevant optimum moisture content and to provided alternate disposal to plastic. Pragyan Bhattarai et al. [2] In this paper the collection of plastic waste should be done on the basis of different aspect ratio which having the strip width on average 10mm and which are passing through 40 micron IS sieve having different aspect ratio for 10mm thick strip the aspect ratio is given by (AR=1) for 20mm thick plastic strip the aspect ratio is given by (AR=2), up to AR=4. Then this all various size plastic strips are then used as a

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stabilizer at a percentage of 0%, 0.25%, 0.5% and 1% of plastic content. This study should conclude that as the aspect ratio of plastic strips increases this CBR and other properties of soil increases up to a certain limit i.e. optimum limit for plastic content. Kirubakaran.K. et.al [3] In this experimental study the stabilization of soil i.e. Black Cotton Soil is done by using PET (Polyethylene Terephthalate) for different percentage with having size mean less than 0.5mm and 1mm. according to the performance analysis the CBR value of soil increases upto 5%. Arpitha G.C.et.al [4] In this study the stabilization of red soil is to be carried out by using the waste plastic i.e. PET (Polyethylene Terephthalate) with the comparatively study of waste bag i.e. low density plastic. From this study it should be conclude that the consolidated CBR by using plastic strips should be more than that of by using plastic bag waste and it is fund to be 0.75% plastic strip is optimum plastic content to get the maximum strength to soil and by using plastic waste bags the optimum strength is found to be 2%. Gowtham S. et.al [5] In this study stabilization of clay soil with the help of glass and plastic waste powder should be studied. The plastic used in this study of specification, it has sp. gravity of 0.12 with the mean length of plastic waste is 12mm and that of glass powder is added to release Enzymes in soil and provide bond of soil with plastic. From this study it should conclude that the optimum plastic and glass powder content is 6% to get maximum CBR value.

III. METHODOLOGY

Sample Collection

1. Black Cotton Soil

The black cotton soil procured from nearby proposed Samruddhi Mahamarg, Shevga, Aurangabad, Maharashtra, India. This soil was collected from an open excavation, at a depth of 1m to 1.5m below the natural ground surface. The Soil used in this study is a blackish gray inorganic clayey soil of medium plasticity. Sufficient quality of soil was brought to the Geotechnical Engineering Laboratory of M.G.M. Polytechnic.

2. Plastic Bottles (PET)

The plastic bottles should be collected from plastic scrap shops and for cutting of this plastic strips manual method is adopted because the laboratory work is done at very low stage so quantity of plastic (PET) strips is required is less and that having mean dimension 2.5cm. i.e. AR = 1(2.5:0.4). For large scale project mechanical cutting should be adopted.

3. Marble Dust Powder

The collection of Marble Dust Powder should be done from Marble industry i.e. Surya Stone Industries near API Corner, Cidco, Aurangabad, Maharashtra, India. The MDP is usually greyish white in colour which has more bounding properties. The MDP used for this test which should be passed through 90 μ IS sieve. The use of MDP is only to produce bond between plastic waste and soil, for that purpose 5% of MDP is used for this study.

Experimental Work

1. Water Content

It is nothing but moisture content present in untreated soil sample or it is defined as weight of water present in soil to the weight of soil solids in percentage. It should be determined with reference of relevant IS code IS 2720 PART II by oven drying method.

2. Specific Gravity

It is simply defined as the ratio of unit wt. of soil solid to the unit wt. of standard liquid i.e. water. This test should be performed with the help of relevant IS code IS2720 Part III.

3. Atterberg limits

3.1. Liquid Limit (W_L)

It is defined as the minimum water content at which soil is in liquid state, but has a small shearing strength against flowing. It arbitrary limit between liquid and plastic states of consistency of soil.

3.2. Plastic Limit (W_P)

It is defined as water content at which soil is in plastics state. It is arbitrary limit between plastic and semi-solid state of consistency of a soil.

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3.3. Plasticity Index (I_p)

The range of consistency within which a soil exhibits plastics properties is called as plasticity index or plastic range.

4. Standard Proctor Test

When the soil is compacted, it is generally compacted along with adding water. Upto an optimum water content gives maximum dry density to soil. If water content less than that of optimum value or more than optimum value then it will give less compacted density i.e. dry density thus to determine this optimum moisture content the common test is adopted as standard proctor test with relevant IS code IS 2720 part VII.

5. California Bearing Ratio Test

It is ration of force per unit area required to penetrate a soil mass with the circular plunger of 50mm dai. At the penetrating rate of 1.25mm/minute to that required for corresponding penetration or load caring capacity of standard material. simply it the relative measure of penetration of soil w.r.to loading and it is defined as the ratio of load sustained by the specimen at 2.5 or 5mm penetration to the load sustained by Standard Aggregate at corresponding penetration level. For 2.5mm penetration standard load is 1370kg and that of for 5mm penetration the standard load is 2250 kg. This test is very important test is field of geotechnical engineering and highway engineering due to which it plays very important role in case of pavement design.

6. Unconfined Compressive Test

This test used to determine Compressive and Shear Strength of soil is performed with reference of IS2720 part 10.

IV. EXPERIMENTAL RESULTS

The properties of black cotton soil should be determined with the help of relevant IS codes as the mention below with the test result of soil.

Table.no.1 shows the properties of black cotton soil i.e. un-treated soil (BSC+ 0% PET+ 0% MDP).

Sr. No	Properties	Before Stabilization
		BSC+ 0% PET+ 0% MDP
1	Index Properties	
	Water Content	7.55%
	Specific Gravity	2.73
	Atterberg Limit	
	Liquid Limit	64.48%
	Plastic Limit	35.91%
	Plasticity Index	28.56%
2	Standard Proctor Test	
	MDD	1.49gm/cm ³
	OMC	26.08%
3	CBR	
	Unsoak	2.49%
	Soak	2.14%
4	Unconfined Compressive Test	
	Compressive Strength	1.25gm/cm ²
	Shear Strength	0.625gm/cm ²

Plastic waste bottle strips (PET) with Marble Dust Powder (MDP) which is pass through 90 μ IS sieve into the Black Cottons Soil (BCS) with percentage of 0%, 1%, 2%, 3%, and 4% with the 5% of MDP as a bounding agent between soil and plastic waste strips (PET). The table below shoving the graphical representation of compaction cueve at various condition of various dosage of plastic.

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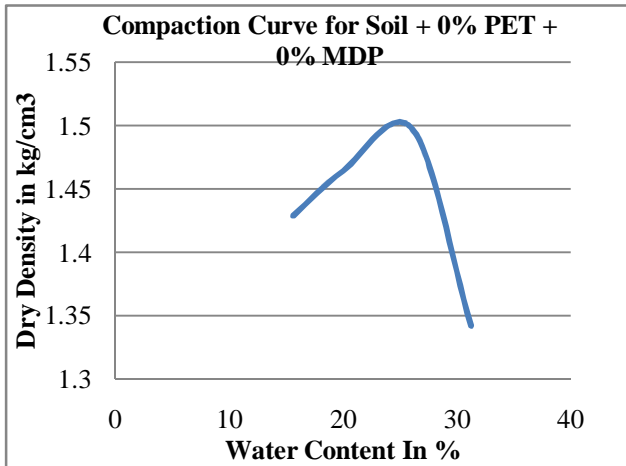


Fig.No.1.

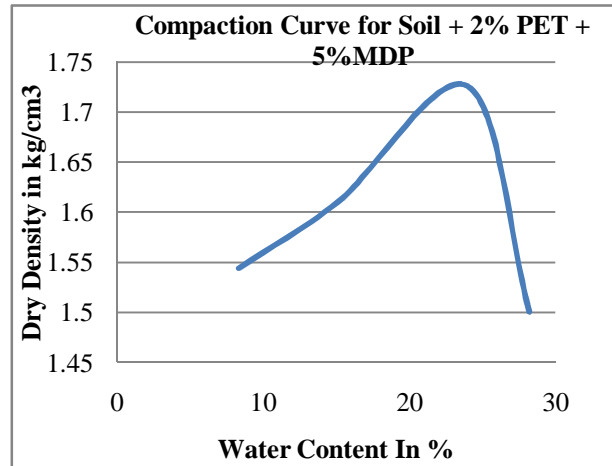


Fig.No.2.

The fig.1. shows the compaction curve of soil at condition Soil + 0% PET + 0% MDP i.e. plain soil at which MDD is 1.5 gm/cm³ and MDD of 26.08%. The fig.2. shows the compaction curve of soil at condition Soil + 2% PET + 5% MDP i.e. plain soil at which MDD is 1.63 gm/cm³ and MDD of 25%.

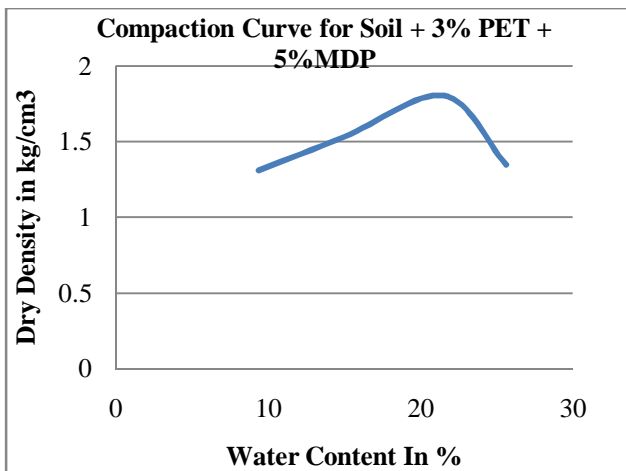


Fig.No.3.

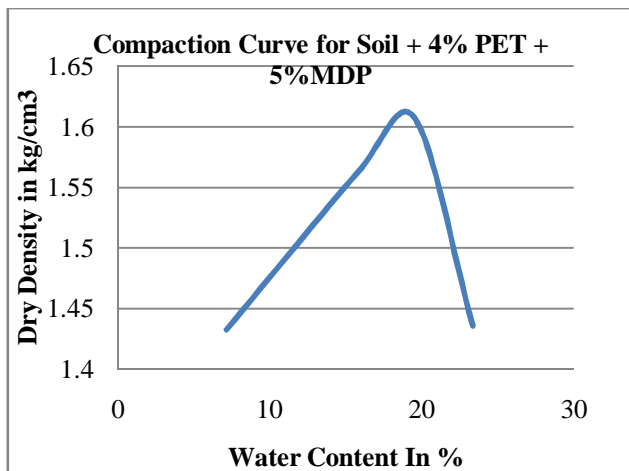


Fig.No.4

The fig.3. shows the compaction curve of soil at condition Soil + 2% PET + 5% MDP i.e. plain soil at which MDD is 1.73 gm/cm³ and MDD of 24%. The fig.4. shows the compaction curve of soil at condition Soil + 3% PET + 5% MDP i.e. plain soil at which MDD is 1.83 gm/cm³ and MDD of 21.53%.

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Compaction Characteristics of BCS

Table.no.2. shows the compaction characteristic of black cotton soil.

The compaction character of soil gives the optimum PET content at which soil will possess maximum dry density and optimum water content as shown in fig below; in 3%PET + 5%MDP the maximum result should be obtained i.e. maximum dry density 18 gm/cm³ at optimum moisture content of 21.53%.

Material	MDD in gm/cm ³	OMC in %
BCS + 0% PET + 0% MDP	1.5	26.08
BCS + 1% PET + 5% MDP	1.63	25
BCS + 2% PET + 5% MDP	1.73	24
BCS + 3% PET + 5% MDP	1.8	21.53
BCS + 4% PET + 5% MDP	1.61	19.4

CBR test result

Table.no.3. Load-Penetration Relations of CBR Test of un-soak CBR.

The table below shows the load penetration relation of different dosage of PET content at which soil shows the differential penetration and load applied on soil in un-soak CBR condition.

Penetration In mm	Loading In kg				
	0% PET	1% PET	2% PET	3% PET	4% PET
0	0	0	0	0	0
0.5	10.43	18.32	23.73	30.25	27.12
1	18.91	28.94	32.33	41.98	34.23
1.5	24.7	35.86	41.14	55.28	48.18
2	29.60	43.22	50.13	61.22	56.01
4	40.09	60.63	65.72	88.60	70.09
5	47.59	64.87	70.28	95.77	76.61
7.5	59.52	80.97	85.47	103.86	95.12
10	74.98	91.21	95.51	112.86	106.27
12.5	81.5	101.32	110.25	123.03	112.53

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Table.no.4. Load-Penetration Relations of CBR Test of soak CBR.

The table below shows the load penetration relation of different dosage of PET content at which soil shows the differential penetration and load applied on soil in soak CBR condition.

Penetration In mm	Loading In kg				
	0% PET	1% PET	2% PET	3% PET	4% PET
0	0	0	0	0	0
0.5	7.49	13.04	22.82	26.99	21.84
1	14.67	22.10	30.97	38.72	31.29
1.5	18.84	28.94	40.48	48.76	42.38
2	26.01	34.81	45.90	54.70	47.59
4	37.49	49.48	59.91	68.72	63.43
5	42.38	56.72	68.72	79.47	71.06
7.5	53.79	66.96	83.19	90.10	84.69
10	65.526	74.91	91.21	98.06	93.43
12.5	71.98	80.78	96.17	103.47	97.86

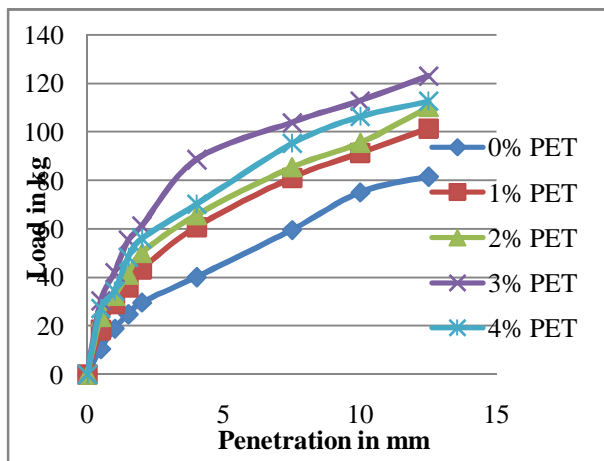


Fig.No.5

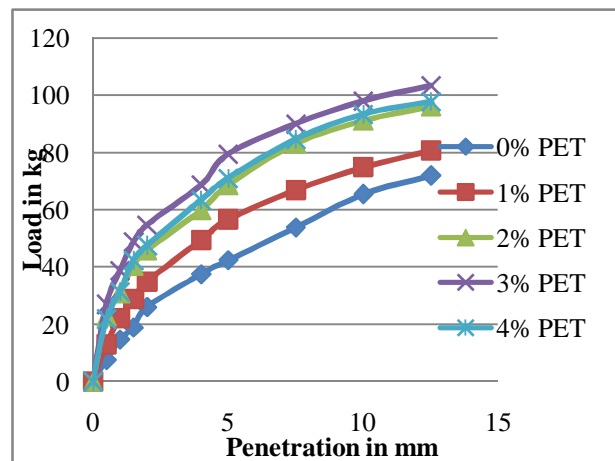


Fig. No 6.

The fig.5. Compaction curve for different PET content (un-soak) The fig.6 Compaction curve for different PET content (soak)

The fig above gives the various load penetration curve of different dosage of plastic w.r.to penetration and load. Shows the optimum dosage of plastic at which soil should give the maximum penetration value i.e. CBR value. From above all condition maximum result should obtain at BCS + 3% PET + 5%MDP.

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Table.no.5. test result of CBR on soil w.r.to different plastic (PET) content
The table below shows relative measure of optimum dosage of PET at which soil gives the maximum penetration value i.e. CBR value in soak and un-soak condition

% PET	CBR (un-soak) value		CBR (soak) value	
	At 2.5mm	At 5mm	At 2.5mm	At 5mm
0	2.49	2.31	2.14	2.06
1	3.21	3.15	3.01	2.76
2	4.31	3.42	3.83	3.34
3	5.31	4.66	4.42	3.86
4	4.42	3.72	3.87	3.45

Unconfined Compressive Test

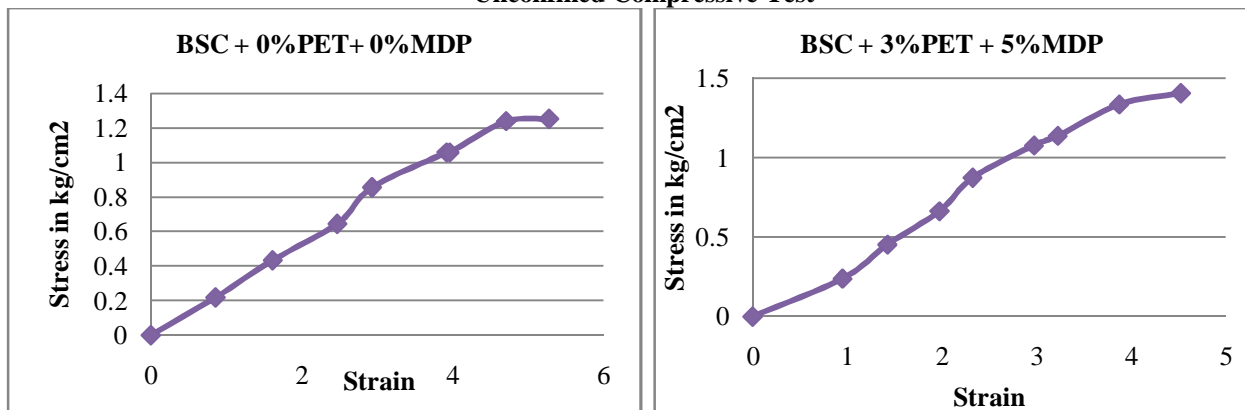


Fig.No.7

Fig.No.8

The fig.7. Stress-Strain Curve for BSC + 0%PET+ 0%MDP. The fig.8. Stress-Strain Curve for BSC + 3%PET+ 5%MDP (this condition given the maximum dry density as well as CBR value)

Table.no.6. Compressive and Shear Strength of Soil

Condition	Compressive strength (kg/cm ²)	Shear strength (kg/cm ²)
BSC + 0%PET+ 0%MDP	1.25	0.625
BSC + 3%PET+ 5%MDP	1.41	0.705

The table above shows the comparison between compressive strength and shear strength of soil i.e. BSC + 0%PET+ 0%MDP (plain soil) with stabilized soil i.e. BSC + 3%PET+ 5%MDP.

V. CONCLUSION

From the above study, following are the conclusion made,

- In present study the Dry Density, CBR value, Compressive Strength and Shear Strength of soil increase at the plastic (PET) content of 3% having Aspect Ratio 1 with 5% of MDP as the bounding material between soil and plastic (PET).

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- This study also gives the plastic proper disposal and gives the soil for long time stabilization i.e. the decomposition period of plastic is more than other material and this study help to get stabilized soil economically i.e. save the cost of other stabilizer.
- The optimum result (performance) of soil is at BSC + 3%PET+ 5%MDP at this condition the maximum dry density of soil is found to be 1.83gm/cc with CBR value of 5.31% (un-soak).as he expansion soil having good compressive strength but still by using plastic compressive as well as shear strength of soil is 1.41kg/cm² and 0.705kg/cm².

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