

Study on Stabilization of Black Cotton Soil by Using Stone Dust & Polypropylene Fibers

Dhananjay Kumar Tiwari¹, Dr. R.K.Dixit², Dr. Subrat Roy³P.G. Student, Department of Civil and Environmental Engineering, NITTTR Bhopal, India¹Professor, Department of Civil and Environmental Engineering, NITTTR Bhopal, India²Professor, Department of Civil and Environmental Engineering, NITTTR Bhopal, India³

ABSTRACT: Black cotton soil have the tendency to swell or shrink depending on its moisture content. Due to such expansive characteristics of soil, the structures constructed over this may develop some cracks in due course of time. It is there for essential to stabilize such soils, prior to any construction work carried out on this to improve its engineering properties. At present waste materials like stone dust from crushers, fly ash from industry and plastic waste are in abundance at various parts of our country. These wastes not only create health problems but also its disposal is a great problem for our society. This paper deals with a feasibility study carried out to find the suitability of using waste material i.e. stone dust and polypropylene fibers as stabilizing material for improving the engineering properties of black cotton soil. Various tests like CBR, UCS were performed on the soil samples prepared by using stone dust and Polypropylene fibers mixed with black cotton soil at different percentages. On the basis of the results obtained from these tests, it may be concluded that the strength of black cotton soil can be substantially improved by mixing with stone dust and polypropylene fibers as stabilized materials.

KEYWORDS: Black Cotton Soil, Soil Stabilization, Stone Dust, Polypropylene Fibers, Compressive Strength,

I. INTRODUCTION

Black Cotton Soil also known as expansive soil, mainly found in the central India and Deccan plateau such as Maharashtra, Western Madhya Pradesh, Chhattisgarh, Andhra Pradesh, Karnataka, etc. Geotech engineers are constantly searching for new and suitable engineering methods for improving the engineering properties black cotton soil. Our building projects, airports, railway station generates huge quantity of waste materials such as stone dust, plastic fibers, demolished concrete wastes, etc and engineers are consistently looking for using these waste as stabilizing material for black cotton soil. In this Paper present a study, carried out on soil stabilization using stone dust and polypropylene fibers for improving the property of expansive clayey soils. Various tests like CBR, UCS were performed on the soil samples prepared by using stone dust and Polypropylene fibers mixed with black cotton soil at different percentages. On the basis of th results obtained from these tests, it may be concluded that the strength of black cotton soil can be substantially improved by mixing with stone dust and polypropylene fibers as stabilized materials.

II. LITERATURE REVIEW

Soil stabilization is a procedure where we improve engineering properties of soil with the use of natural or synthesized admixtures. In the past many researchers have carried out their research work for improving the strength of black cotton soil using different types of admixture at different percentages. The present paper deals with the stabilization of black cotton soil using stone dust and polypropylene fibers. A detailed literatures have been reviewed on this topic i.e. related to black cotton stabilization and some of the reviewed literatures are presented in proceeding paragraphs.

Muntohar et.al (2013) Conducted laboratory tests to evaluate the engineering properties of silty soil stabilized with lime, waste plastic fibers and rice husk ash. They have conducted CBR, UCS shear strength test to find out the strength

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of stabilized soil. From the test results, they have concluded that the proposed methodology is very effective for improving the engineering properties the clayey soil.

Kumarwat et.al (2014) studied the effect of calcium carbide residue (CCR) and stone dust particle as a stabilized material on the property of black cotton soil. They have mixed stone dust and CCR in different percentages with black cotton soil and conducted various tests like UCS, OMS & MDD, CBR, etc on the prepared soil samples. From the tests results, they have demonstrated that when stone dust and CCR mixed in equal amount (10% -10%) gives the better results on the improvement of engineering properties of soil.

III. EXPERIMENTAL INVESTIGATIONS

Various such as Atterberg's limit (liquid and plastic limit) , CBR, UCS, OMC & MDD, etc tests have been performed to find out the engineering properties of black cotton soil as well as the soil mixed with stone dust and polypropylene fibers as stabilized material.

3.1 Material Used –

- Black Cotton Soil - About 150kg of soil sample for the present work was collected from the JK ROAD BHOPAL region.
- Stone Dust - Stone dust for the present work was obtained from stone crusher located at SINDHI COLONY, BERASIA ROAD BHOPAL Region.
- Polypropylene Fibers – Polypropylene Fibers having length of 12mm & unit weight of 0.91g/cm³ were purchased from NAGPUR, MAHARASHTRA Region.

3.2 Laboratory tests carried out on soil samples

- Tests were carried out on the virgin soil sample to find out atterberg's limit as per the procedure mentioned in IS 2720 (Part5) 1985. From the test results, plasticity index of the virgin black cotton soil was found to be 25.68 and hence the soil sample can be categorized as clay with high plasticity.
- Virgin black cotton soil were mixed in varying percentages of Stone dust and Polypropylene Fibers by the weight of soil sample & the details are given in Table 3.1

Table 3.1 : Percentages of virgin soil mixed with stone dust & polypropylene fibers

Soil	Stone Dust (%)	Polypropylene Fibers (%)
Virgin Black Cotton Soil	5%	0.50%
		1.00%
		1.50%
	10%	0.50%
		1.00%
		1.50%
	15%	0.50%
		1.00%
		1.50%
	20%	0.50%
		1.00%
		1.50%

3.3 Standard Proctor Test – Proctor tests were conducted to find out the OMC & MDD of the virgin soil samples and also the soil samples mixed with various percentages of Stone dust and Polypropylene Fibers as given in Table 3.1. For these tests procedure is given in IS 2720 (Part7) 1980. The test results are given in Table 3.2. OMC & MDD of virgin soil were found to be 20.3% and 1.67 g/cm³ respectively.

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Table 3.2 OMC & MDD of the soil mixed with stone dust & polypropylene fibers

Stone Dust (%)	Polypropylene Fibers (%)	Virgin Soil (%)	Water Content (%)	Max. Dry Density (g/cm ³)
-	-	100	20.3	1.67
5%	0.50	94.5	19.5	1.65
	1.00	94	19.5	1.64
	1.50	93.5	19.5	1.63
10%	0.50	89.5	17	1.711
	1.00	89	17.4	1.70
	1.50	88.5	18	1.68
15%	0.50	84.5	15.5	1.757
	1.00	84	15.8	1.73
	1.50	83.5	16	1.70
20%	0.50	79.5	15.3	1.73
	1.00	79	15.9	1.70
	1.50	78.5	16.0	1.69

3.4 California Bearing Ratio – CBR tests were conducted on the virgin soil samples and also samples mixed with various percentages of Stone dust and Polypropylene Fibers as given in Table 3.1. For these tests, the procedure given in IS 2720 (Part16) 1987 were follow. The test results are given in Table 3.3. CBR of virgin soil was found to be 1.59.

Table 3.3: CBR of the soil mixed with stone dust & polypropylene fibers

Stone Dust (%)	Polypropylene Fibers (%)	Virgin Soil (%)	CBR value at 2.5mm Penetration
-	-	100	1.59
5%	0.50	94.5	4.50
	1.00	94	4.93
	1.50	93.5	5.11
10%	0.50	89.5	5.24
	1.00	89	5.79
	1.50	88.5	5.29
15%	0.50	84.5	3.98
	1.00	84	3.60
	1.50	83.5	2.69
20%	0.50	79.5	2.65
	1.00	79	1.90
	1.50	78.5	1.67

3.5 Unconfined Compressive Strength – UCS tests were conducted on the Unconfined Compressive Strength of the virgin soil sample and also samples mixed with various percentages of Stone dust and Polypropylene Fibers as given in Table 3.1. For these tests, the procedure given in IS 2720 (Part10) 1991 were followed. The test results are given in Table 3.4. Unconfined Compressive Strength of virgin soil was found to be 11.76 N/cm².

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Table 3.4: UCS of soil mixed with stone dust & polypropylene fibers

Stone Dust (%)	Polypropylene Fibers (%)	Virgin Soil (%)	Axial Stress (N/cm ²)	Axial Strain (%)
-	-	100	11.76	9.92
5%	0.50	94.5	21.50	9.08
	1.00	94	20.42	9.14
	1.50	93.5	19.88	8.45
10%	0.50	89.5	24.13	8.34
	1.00	89	25.92	8.97
	1.50	88.5	23.07	8.92
15%	0.50	84.5	21.55	9.08
	1.00	84	20.68	9.74
	1.50	83.5	19.57	8.22
20%	0.50	79.5	20.92	9.00
	1.00	79	18.42	8.84
	1.50	78.5	16.70	8.95

IV. DISCUSSIONS ON THE TEST RESULTS

4.1 Discussion on the Standard Proctor Test results

OMC & MDD of the virgin soil was found to be 20.3% and 1.67 g/cm³ respectively. From the test results, it was found that the Optimum Moisture Content decreases and the maximum dry density increases with the addition of stone dust and polypropylene fibers & maximum value of MDD was found to be 1.757 g/cm³ with 15.5% OMC at 15% stone dust and 0.50% polypropylene fibers and minimum value of MDD was found to be 1.63 g/cm³ with 19.5% OMC at 5% stone dust and 1.50% polypropylene fibers .

4.2 Discussion on the California bearing ratio results

CBR value of virgin black cotton soil obtained as 1.59. From the test results, it was found that the CBR value of black cotton soil increases with the addition of stone dust and polypropylene fibers & maximum value of CBR was found to be 5.79 at 10% stone dust and 1.00% polypropylene fibers and minimum value of CBR was found to be 1.67 at 20% stone dust and 1.50% polypropylene fibers .

4.3 Discussion on the Unconfined compressive strength results

Unconfined compressive strength of virgin black cotton soil was found 11.76 N/cm². From the test results, it was found that the UCS of soil was increases with the addition of stone dust and polypropylene fibers. Maximum value of UCS was found to be 25.92 at 10% stone dust and 1.00% polypropylene fibers and minimum value was found to be 16.70 N/cm² at 20% stone dust and 1.00% polypropylene fibers.

V. CONCLUSIONS

On the basis of experimental investigations & results obtained, following conclusion can be drawn –

- The CBR value of virgin black cotton soil obtained as 1.59. On the addition of Stone dust & Polypropylene fibers, the value of CBR increased and the maximum value of CBR was found to be 5.79% with 10% stone dust and 1.00% polypropylene fibers respectively.
- Unconfined compressive strength of virgin black cotton soil was found to be 11.76 N/cm². UCS of soil was increased with the addition of stone dust and polypropylene fibers & maximum value of UCS was found to be 25.92 with 10% stone dust and 1.00% polypropylene fibers respectively.

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- Hence, from the above test results, it can be concluded that the Black Cotton Soil can be used as a sub grade soil for road construction after Stabilizing using stone dust and polypropylene fibers.

REFERENCES

- [1] Suresh.K, Padmavathi.V and Apsar Sultana, Experimental Study on Stabilization of black Cotton soil with Stone Dust and Fibers, Indian Geotechnical Conference, 2009, pp 502-506.
- [2] Amin.C, and Hamid.N, CBR Test on Fiber Reinforced Silty Sand, International Journal of Structural and Civil Engineering, 1, 2012, pp 1-9.
- [3] Kumarawat, N., and Ahirwar, S.K. (2014). "Performance Analysis of Black Cotton Soil Treated With Calcium Carbide Residue and Stone Dust" International Journal of Engineering Research and Research and Science &Technology: Vol.3, No. 4, Nov. 2014
- [4] Parsons, R. and Kneebone, E. (2004). "Use of Cement Kiln Dust for the Stabilization of Soils" Geotechnical Engineering for Transportation Projects: pp. 1124-1131
- [5] Muntohar, A., Widianti, A., Hartono, E., and Diana W. (2013) "Engineering Properties of Silty Soil Stabilized with Lime and Rick Hush Ash and Reinforced with Waste Plastic Fiber" Journal of materials in Civil Engineering, 25(9), 1260-1270
- [6] Prof. S. Ayyappan, Ms. K. Hemalata, Prof. M. Sundaram. (2010). "Investigation of Engineering Behavior of Soil, Polypropylene Fibers and Fly Ash-Mixtures for Road Construction" . International journal of Environmental Science & Development, vol. 1 (2),pp 171-175.
- [7] Hopibulsuk, S., Phetchuay, C., and Chinkulkijniwat, A.(2012). "Soil Stabilization by Calcium Carbide Residur and Fly Ash." Journal of Materials in Civil Engineering, 24(2), 184-193.
- [8] Choudhary, A., Jha, J., and Gill, K. (2010). "Utilization of Plastic Wastes for Improving the Sub grades in Flexible Pavements." Paving Materials and Paving Analysis: pp. 320-326
- [9] Satyanarayana, B. (1966). "Swelling Pressure and Related Mechanical Properties of Black Cotton Soils",
- [10] Ali and Sunil Koranne. 2011 "Performance Analysis of Expansive Soil Treated With Stone Dust and Fly ash". As, Vol. 16 Bund.