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STRENGTHENING BLACK COTTON SOIL WITH RHA AND MOORUM FOR PAVEMENT SUBGRADE

BALWANT RAMTEKE[1] & A. K. SAXSENA[2]

[1]M. Tech. Student, Department of Civil Engineering, LNCT Engineering College Bhopal, MP, India

[2]Associate Professor & Head, Department of Civil Engineering, LNCT Engineering College Bhopal, MP, India

ABSTRACT

Due to variable nature of soil, the subgrade strength changes inconsistently, as a result engineers face so many difficulties or challenges during the design of a pavement. The subgrade strength is very much dependent on moisture content. As the subgrade is intended to variation of moisture due to precipitations or other climatic changes, it is necessary to enable or understand the subgrade according to the variation of moisture. Black cotton soil (weak soil) can be strengthened by stabilizing it with agriculture waste material and locally available material like Rice Husk Ash and Moorum. It can be one of the economic and effective methods of stabilization. Geotechnical properties of virgin black cotton soil and the soil treated with RHA and Moorum with10%, proportions and RHA taken to be 10% which is the optimum does for black cotton soil. The positive response has been observed with the addition of RHA and moorum.

KEYWORDS: Black Cotton Soil, Moorum, Pavement, Rise Husk Ash & Stabilization

INTRODUCTION

Black cotton soil covers nearly 20% of the Indian sub-continent. Highways and roadways constitute a major activity in the black cotton soil areas. It has been the common observation and experience that the pavements of highways and roadways constructed either on insitu soil formation or on compacted black cotton soil embankment shows several types of damages to pavement structures, and in many instances the pavement may even become unserviceable because of highly deteriorated condition of the whole pavement system. Technical improvement in the pavement construction is need of the day to avoid huge losses incurred due to failure of pavement especially in a cash strapped country like India. Anil Kumar Singhai[1], Sudhanshu Shekhar Singh[2] has studied in his experimental work used Fly Ash and RHA the waste material for up grading the expansive soil for construction purposes. Addition of such materials increases the physical as well as the chemical properties of the soil. The author added the waste materials in black cotton soil to evaluate the effect of fly ash and Rice Husk ash to improve the properties of soil like CBR value, shear strength, liquid limit, plastic limit, plasticity Index and the bearing capacity of soil and found the considerable improvement in liquid limit, plasticity index and free swell index.

MATERIALS AND PROPERTIES

The following materials are used in the study for stabilization of Black cotton soil.

Black Cotton Soil

The soil used for this study is a predominantly Black Cotton Soil. The soil sample was collected from Navegao, District Gadchiroli in Maharashtra. The soil was collected by open excavation at a depth of around 1.0 m from natural

ground surface. The soil taken was air dried and pulverized to pass through IS 425 micron sieve and then oven dried at 110^0 C before testing.

Table No. 1: Properties of Natural Soil

Sr. No.	Properties	Results Obtained
1	Specific Gravity	2.67
2	Grain Size Distribution	
	Sand	14.28 %
	Silt	85.72 %
	Gravel	0 %
	IS Soil Classification	MH
	AASHTO Classification	A-7
3	Liquid limit	60.65 %
4	Plastic limit	38.59 %
5	Plasticity Index	22.06 %
6	Free swelling Index	150 %

Rice Husk Ash

Rice Husk is the shells produced during de-husking operation of paddy. The burning of rice husk generates about 20% of its weight as Rice Husk Ash (RHA). For the present work, the RHA was obtained from the open clay brick kill at Pardi, District Gadchiroli, Maharashtra. Well burnt Rice Husk Ash passing through 425 micron IS sieve was used for this study. The chemical compositions are given in table below.

Table 2: Properties of Rice Husk Ash

Sr. No.	Properties	Results Obtained
1	SiO_2 (%)	72.24
2	CaO (%)	4.12
3	MgO (%)	1.7
4	$Fe_2O_3 + Al_2O_3$	7.2
5	Specific Gravity	1.87
6	Lime Reactivity (kg/cm^2)	34

Moorum

The weathered rock fragments which are gravelly and non-plastic in nature are locally called as Moorum. The granular moorum is collected from Bhagwanpur, District Gadchiroli, Maharashtra. The moorum taken was air dried and pulverized to pass through IS 425 micron sieve and then oven dried at 110^0 C before testing.

METHODOLOGY

Initially the properties of natural soil are determined. The soil is then stabilized with RHA and Moorum. The amount of RHA taken is 10% by dry weight of soil and moorum in 10%, Using this proportion, mixed sample were prepared as given below and a set of laboratory test were performed to determine the index properties of samples. Mixed proportion samples of soil, RHA used for stabilization.

- Natural Soil
- Soil + 10% RHA
- Soil + 10% RHA+10% Moorum

RESULTS AND DISCUSSIONS

PROPERTIES OF NATURAL SOIL

Liquid Limit

Table 3: Liquid Limit of Natural Soil

Sr. No.	Particulars	Trial- 1	Trial- 2	Trial-3	Trial- 4	Trial- 5
1	No. of Blows	35	30	25	19	15
2	Container No	1	2	3	4	5
3	Wt of container + Wet Soil	31.470	36.685	39.275	33.710	38.390
4	Wt of container + Dry Soil	25.105	28.180	29.610	26.125	28.960
5	Loss of Moisture	6.365	8.505	9.665	7.585	9.430
6	Wt of container in gm	14.315	13.960	13.675	13.665	14.080
7	Wt of Dry Soil	10.790	14.220	15.935	12.460	14.880
8	Moisture Content %	58.990	59.810	60.653	60.875	63.374

Liquid limit = 60.65 %

Plastic Limit

Table 4: Plastic Limit of Natural Soil

Sr. No.	Particulars	Trial- 1	Trial- 2	Trial- 3
1	Container No	6	7	8
2	Wt of container + Wet Soil	21.420	16.185	22.860
3	Wt of container + Dry Soil	19.820	19.750	20.855
4	Loss of Moisture	1.600	3.565	2.005
5	Wt of container in gm	14.310	13.280	14.515
6	Wt of Dry Soil	5.510	6.470	6.340
7	Moisture Content %	29.038	55.100	31.625
	Average plastic limit %	38.59%		

Plastic limit = 38.59%

Plasticity Index = Liquid Limit – Plastic Limit

Plasticity Index = 60.65 - 38.59

= 22.06 %

Compaction Test

Table 5: Compaction Test of Natural Soil

Sr. No.	Weight of Mould + Compacted Soil W2 (gms)	Weight of Wet Soil W2 - W1 (gms)	Wet Density (gms/ cm^3)	Moisture Content Determination					
				Wt of Container + Wet Soil (gms)	Wt of Container + Wt of Dry Soil (gms)	Weight of Water (Ww) (gms)	Weight of Dry Soil (Ws) (gms)	Moisture Content (%) (W)	Dry Density (gm/ cm^3)
1	6292	1600	1.60	1326	1213	113	887	12.73	1.41
2	6350	1658	1.69	1324	1189	135	865	15.60	1.43
3	6412	1720	1.72	1342	1198	144	856	16.82	1.47
4	6452	1760	1.76	1350	1.199	151	849	17.78	1.49
5	6534	1842	1.84	1348	1.181	167	833	20.04	1.53
6	6536	1844	1.84	1360	1.183	177	823	21.50	1.51

M.D.D = 1.53 **O.M.C = 20.04%**

PROPERTIES OF SOIL +10% RHA

Liquid Limit

Table 6: Liquid Limit of Soil +10% RHA

Sr. No.	Particulars	Trial- 1	Trial- 2	Trial-3	Trial- 4	Trial- 5
1	No. of Blows	35	27	25	20	15
2	Container No.	9	10	11	12	13
3	Wt of container + Wet Soil	38.280	39.510	40.945	41.945	42.435
4	Wt of container + Dry Soil	30.745	31.405	32.450	32.885	32.950
5	Loss of Moisture	7.535	8.105	8.495	9.060	9.485
6	Wt of container in gm	15.470	15.270	15.990	15.730	15.560
7	Wt of Dry Soil	15.275	16.135	16.460	17.155	17.390
8	Moisture Content %	49.329	50.232	51.610	52.813	54.543

Liquid Limit = 51.61 %

Plastic Limit

Table 7: Plastic Limit of Soil +10% RHA

Sr. No.	Particulars	Trial- 1	Trial- 2	Trial- 3
1	Container No	14	15	16
2	Wt of container + Wet Soil	20.505	23.165	24.015
3	Wt of container + Dry Soil	18.465	21.220	21.920
4	Loss of Moisture	2.040	1.945	2.095
5	Wt of container in gm	11.970	15.200	15.510
6	Wt of Dry Soil	6.495	6.020	6.410
7	Moisture Content %	31.409	32.309	32.683
	Average plastic limit %	32.13		

Plastic Limit = 32.13%

Plasticity Index = Liquid Limit – Plastic Limit

Plasticity Index = 51.61 – 32.13

= 19.48%

Compaction Test

Table 8: Compaction Test of Soil + 10% RHA

Sr. No.	Weight of Mould + Compacted Soil W2 (gms)	Weight of Wet Soil W2 - W1 (gms)	Wet Density (gms/ cm^3)	Moisture Content Determination					
				Wt of Container + Wet Soil (gms)	Wt of Container + Wt of Dry Soil (gms)	Weight of Water (Ww) (gms)	Weight of Dry Soil (Ws) (gms)	Moisture Content (%) (W)	Dry Density (gm/ cm^3)
1	6640	1948	1.95	1336	1091	245	755	32.45	1.471
2	6659	1967	1.97	1338	1090	248	752	32.98	1.479
3	6687	1995	2.00	1358	1103	255	745	34.23	1.486
4	6686	1994	1.99	1340	1078	262	738	35.50	1.472
5	6698	2006	2.01	1344	1071	273	727	37.55	1.458
6	6708	2016	2.02	1350	1063	287	713	40.25	1.437

M. D. D = 1.48 **O. M. C = 34.23 %**

PROPERTIES OF SOIL +10% RHA+ 10% MOORUM

Liquid Limit

Table 9: Liquid Limit of Soil +10% RHA+ 10% Moorum

Sr. No.	Particulars	Trial- 1	Trial- 2	Trial-3	Trial- 4	Trial- 5
1	No. of Blows	35	29	25	17	15
2	Container No.	1	2	4	3	5
3	Wt of container + Wet Soil	33.830	36.100	38.990	39.270	40.120
4	Wt of container + Dry Soil	27.715	29.055	30.790	30.790	31.315
5	Loss of Moisture	6.115	7.045	8.200	8.480	8.805
6	Wt of container in gm	14.315	13.960	13.665	13.675	14.080
7	Wt of Dry Soil	13.400	15.095	17.125	17.115	17.235
8	Moisture Content %	45.634	46.671	47.883	49.547	51.088

Liquid Limit = 47.80%

Plastic Limit

Table 10: Plastic Limit of Soil + 10% RHA+ 10% Moorum

Sr. No.	Particulars	Trial- 1	Trial- 2	Trial- 3
1	Container No	6	7	8
2	Wt of container + Wet Soil	23.910	24.290	25.585
3	Wt of container + Dry Soil	21.540	21.710	23.005
4	Loss of Moisture	2.370	2.580	2.580
5	Wt of container in gm	14.310	13.280	14.515
6	Wt of Dry Soil	7.230	8.430	8.490
7	Moisture Content %	32.780	30.605	30.389
	Average plastic limit %	31.26		

Plastic Limit = 31.26%

Plasticity Index = Liquid Limit – Plastic Limit

Plasticity Index = 47.80 – 31.26

= 16.54%

Compaction Test

Table 11: Compaction Test of Soil + 10% RHA+ 10% Moorum

Sr. No.	Weight of Mould + Compacted Soil W2 (gms)	Weight of Wet Soil W2 - W1 (gms)	Wet Density (gms/cm^3)	Moisture content Determination					
				Wt of Container + Wet Soil (gms)	Wt of Container + Wt of Dry Soil (gms)	Weight of Water (Ww) (gms)	Weight of Dry Soil (Ws) (gms)	Moisture Content (%) (W)	Dry Density (gm/ cm^3)
1	6480	1788	1.79	1336	1202	134	866	15.47	1.548
2	6526	1834	1.83	1338	1202	136	864	15.74	1.585
3	6621	1929	1.93	1358	1216	142	858	16.55	1.655
4	6687	1995	2.00	1326	1176	150	850	17.65	1.696
5	6538	1846	1.85	1344	1190	154	846	18.20	1.562
6	6402	1710	1.71	1353	1198	155	845	18.34	1.445

M.D.D = 1.70 O.M.C = 17.65 %

CONCLUSIONS

The study reveals that by the addition of 10% RHA and 10% Moorum in the natural soil there is improvement in the properties of natural soil. Liquid limit, Plastic Limit, Plasticity Index decreases after stabilizing with the above content. The swell index of the stabilized soil sample is also decreased as compared with the natural soil. Finally it can be concluded that Black Cotton soil can be well stabilized with RHA and Moorum.

Due to addition of RHA and Moorum as stabilizer to expansive soil it:

- Reduces the clay content and a corresponding increase in the percentage of coarser particles.
- Reduces the liquid limit (LL) and Plastic limit (PL).
- Hence reduces the plasticity index (PI) of soil, and swelling potential.

REFERENCES

1. Anil Kumar Singhai, Sudhanshu Shekhar Singh, "Laboratory study on soil stabilization using fly ash and rice husk ash", International Journal of Research in Engineering and Technology (IJRET) e ISSN:2319-1163 | p ISSN: 2321-7308. Volume: 03 Issue: 11 Nov-2014.
2. Dr. Robert M. Brooks, "Soil stabilization with fly ash and rice husk ash", International Journal of Research and Reviews in Applied Sciences ISSN: 2076-734X, EISSN: 2076-7366 Volume 1, Issue 3 (December 2009).
3. Sabyasachi Biswas Arghadeep Biswas, Amar Dighade "Utilization of rice husk with lime in subgrade soil for a rural road", International Conference on Emerging Frontiers in Technology for Rural Area (EFITRA) 2012.
4. B. Suneel Kumar, T.V. Preethi, "Behavior of Clayey Soil Stabilized with Rice Husk Ash & Lime", International Journal of Engineering Trends and Technology (IJETT) – Volume 11 Number 1 - May 2014.
5. Mohammed Y. Fattah, Falah H. Rahil, Kawther Y. H. Al- Soudany, "Improvement of Clayey Soil Characteristics Using Rice Husk Ash", Journal of Civil Engineering and Urbanism. Volume 3, Issue 1: 12-18 (2013).
6. Prasad P. Dahale, Dr. P.B. Nagarnaik, Dr. A.R. Gajbhiye, "Utilization of Solid Waste for Soil Stabilization: A Review", EJGE. Vol. 17 [2012], Bund. Q.
7. B.M. Patil, K.A. Patil, "Improvement in Properties of Subgrade Soil by Using Moorum and RBI Grade 81", International Journal of Scientific & Engineering Research, Volume 4, Issue 5, May 2013.
8. Akshaya Kumar Sabat, Radhikesh P. Nanda, "Effect of marble dust on strength and durability of Rice husk ash stabilised expansive soil" International journal of civil and structural engineering. Volume 1, No 4, 2011.
9. Agbede, I. O, and Joel, M, "Effect of rice husk ash (RHA) on the properties of Ibaji burnt clay bricks" American journal of scientific and industrial research. ISSN: 2153-649X doi:10.5251/ajsir.2011.2.4.674.677
10. Koteswara Rao. D Pranav P.R.T, Venkatesh Ganja, "A laboratory study on the efficacy of rice husk ash and potassium chloride for the stabilization of expansive soil" International Journal of Engineering Science and Technology (IJEST) ISSN : 0975-5462 Vol. 4 No.01 January 2012.