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Stabilization of black cotton soil by using rice husk ash, fly ash and coconut coir fibre

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Abstract:- Black Cotton Soils exhibit high swelling and shrinking when exposed to changes in moisture content and hence have been found to be most troublesome from engineering considerations. This behavior is attributed to the presence of a mineral montmorillonite. The wide spread of the black cotton soil has posed challenges and problems to the construction activities. To encounter with it, innovative and nontraditional research on waste utilization is gaining importance now a days. Soil improvement using the waste material like Slags, Rice husk ash, Silica fume etc., in geotechnical engineering has been in practice from environmental point of view. In this paper black cotton soil is treated with 6%,12%,18%,24%,30% of rice husk ash (RHA), 8%,16%,24%,32% of fly ash (FA) and 0.3%,0.6%,0.9%,1.2% of coconut coir fibre (CCF) and atterberg limit, specific gravity, optimum moisture content and maximum dry density is evaluated .

Keywords :- , CCF, FA, MDD, RHA, Soil stabilization

I. INTRODUCTION

In India, the black cotton soil covers a range of around 0.8 million sq. km. which is around 20% of the aggregate area zone. It is considered as dangerous soil because of hindering volume changes with variety in moisture content. When it interacts with water it demonstrates tremendous swelling while it shrinks with the decline in water substance and creates cracks on drying. Now days the usage of waste items with soil has picked up consideration because of the deficiency of suitable soil and expanding issues of mechanical waste administration. The dark color of black cotton soils is because of the vicinity of iron, manganese and titanium in the diminished state. This dirt's are framed under states of poor waste from essential rocks, or in some cases limestone under exchange wet and drying conditions. Huge amount of soil is utilized as a part of the development of roadways however adequate measure of soil of obliged quality may not be accessible effortlessly. Likewise, the expense included in extraction of good quality, normally accessible material is expanding step by step. Successful usage of minor materials as a road development material has been a challenge to the contemporary and imminent designers. This determination give various critical advantages to the developing business and to the nation all in all by protection of common assets, diminishment in the mass of waste to landfills, decreasing the expense of improvement resources, bringing down disposing expenses and by propelling an uncontaminated and green surroundings. The objective of this paper is to upgrade Black Cotton Soil as a construction material using RHA, Fly Ash and CCF which are waste materials.

II. MATERIALS USED

The materials used in this investigation are black cotton soil, rice husk ash, fly ash and coconut coir fibre.

1. Black cotton soil: -

The Black Cotton Soil used in experimental work was brought form Katre Farms, Hingna Nagpur. The Properties of Black Cotton Soil are as shown in table below.

Table -1: Properties of Black Cotton Soil

Properties	Value
Specific gravity	2.35
Liquid Limit	51%
Plastic Limit	28.41%
Plasticity Index	22.59%
Maximum Dry Density	1.41g/cc
Optimum Moisture Content	16.25%

2. Rice husk ash: -

Rice Husk Ash is obtained from the burning of rice husk. The husk is a by-product of the rice milling industry. The RHA used in this study is collected from ellora rice mill, Tumsar, dist. Nagpur.

Table -2: The basic constituent of RHA

Constituents (%mass)	Percent Content
Fe2O3	0.21
SiO2	90.23
CaO	1.58
Al2O3	2.54
MgO	0.53
carbon	2.23
KaO	0.39

3. Fly ash: -

Fly ash is one of the materials available in abundance as a result of industrial by product. It is generated in vast quantity as a result of burning coal in thermal power plants. The main constituent in Fly ash is silica and alumina up to 85% and other is 15%. Fly Ash is collected from Koradi thermal power station, Nagpur.

Table -3: The basic constituent of FA

Constituent of fly ash (% mass)	Values
Silica(SiO2)	60
Alumina(Al2O3)	25
Ferric oxide(Fe2O3)	8.12
Calcium oxide(CaO)	2.9
Magnesium oxide(MgO)	0.82
Titanium oxide(TiO2)	0.24
Free lime content	0.75

4. Coconut coir fibre:-

Coir or coconut fiber belongs to the group of hard structural fibers. It is an important commercial product obtained from the husk of coconut. The coir fiber is elastic enough to twist without breaking and it holds a curl as though permanently waved. Shorter mattress fibers are separated from the long bristle fibers which are in turn a waste in the coir fiber industry. So this coir fiber waste can be used in stabilization of soil and thus it can be effectively disposed off. The inclusion of fibers had a significant influence on the engineering behavior of soil-coir mixtures. Coconut coir fibre is procured from Indian Rickshaw association, Nagpur.

III. METHODOLOGY

The laboratory tests were carried out first on the natural soil which include liquid limit, plastic limit, plasticity index, specific gravity and compaction. A series of laboratory tests were conducted on BC Soil mixed with Rice Husk Ash in various percentages i.e. 6%,12%,18%,24%,30%, with Fly Ash in 8%,16%,24%,32%

and with CCF in 0.3%,0.6%,0.9%,1.2% by weight of dry soil. For the above different proportions, tests are carried out to observe the changes in the properties of soil i.e. maximum dry density and optimum moisture.

IV. RESULTS AND DISCUSSIONS

1. Specific gravity:-

Specific gravity of materials used:

Table - 4: Specific gravity of materials

Materials	**Specific gravity**
Black cotton soil	2.35
Rice husk ash	1.58
Fly ash	1.48

2. Effect of RHA on Atterberg limits:-

Table - 5: Effect of RHA on Atterberg limits

Sr. no.	**Mixture**	**Specific gravity**	**Liquid limit**	**Plastic limit**	**Plasticity index**
1.	Black cotton soil	2.35	51%	28.41%	22.59%
2.	BC soil +6%RHA	2.25	70%	43.45%	26.55%
3.	BC soil +12%RHA	2.24	66.67%	41.06%	25.61%
4.	BC soil +18%RHA	2.23	62%	39.28%	22.72%
5.	BC soil +24%RHA	2.07	50%	38.62%	11.38%
6.	BC soil +30%RHA	1.99	46%	40%	6%

From TABLE 5 it is observed that with increase in % of RHA the specific gravity decreases, while the liquid limit, plastic limit and plasticity index decrease with an increase in % of RHA which also gives us an idea that the soil is heading toward a stable state.

3. Effect of RHA on compaction characteristics:-

Table - 6: Effect of RHA on compaction characteristics

Sr. no.	**Mixture**	**MDD (gm/cc)**	**OMC (%)**
1.	Black cotton soil	1.41	16.25
2.	BC soil +6%RHA	2.72	10
3.	BC soil +12%RHA	2.67	10
4.	BC soil +18%RHA	2.52	10
5.	BC soil +24%RHA	2.45	12.5
6.	BC soil +30%RHA	2.29	14.28

From TABLE 6 it is observed that the optimum moisture content increase with increase in % RHA and maximum dry density decreases with increase in % RHA.

4. Effect of FA on Atterberg limits:-

Table - 7: Effect of FA on Atterberg limits

Sr. no.	Mixture	Specific gravity	Liquid limit (%)	Plastic limit (%)	Plasticity index (%)
1.	Black cotton soil	2.35	51	28.41	22.59
2.	BC soil + 8% FA	2.09	50	35.56	14.44
3.	BC soil + 16% FA	1.99	45	26.50	18.5
4.	BC soil + 24% FA	1.90	42	21.06	21.94
5.	BC soil + 32% FA	1.88	46	30.34	15.66

From TABLE 7 it is observed that with increase in % of FA the specific gravity decreases, while the liquid limit, plastic limit and plasticity index decrease with an increase in % of FA.

5. Effect of FA on compaction characteristics:-

Table - 8: Effect of FA on compaction characteristics

Sr. no.	Mixture	MDD (g/cc)	OMC (%)
1.	Black cotton soil	1.40	16.25
2.	BC soil + 8% FA	2.53	20
3.	BC soil + 16% FA	2.61	18.18
4.	BC soil + 24% FA	2.6	14.28
5.	BC soil + 32% FA	2.76	12.5

From TABLE 8 it is observed that the optimum moisture content decreases with an increase in % of fly ash and maximum dry density increases with increase in % of fly ash. Maximum value of MDD is observed at 32% of fly ash mix while the OMC is varying according to the % of fly ash. However, increase in MDD shows that the soil properties are improving constantly with % of fly ash added.

6. Effect of CCF on compaction characteristics:-

Table - 9: Effect of CCF on compaction characteristics

Sr. no.	Mixture	MDD (g/cc)	OMC (%)
1.	Black cotton soil	1.41	16.25
2.	BC soil + 0.3% CCF	1.55	14.26
3.	BC soil + 0.6% CCF	1.58	13.33

4.	BC soil + 0.9% CCF	1.54	12.78
5.	BC soil + 1.2% CCF	1.51	12.50

From TABLE 9 it is observed that with increase in % of CCF, MDD increases while OMC decreases. Coir fibre is used as reinforcement to the soil. Coir fibre changes the brittle material to ductile material.

V. CONCLUSION

- Liquid limit and plastic limit of BC soil decreases with increasing percentage of FA. Same trend is observed with increase in percentage of RHA.
- OMC decreases with increasing percentage of FA and MDD increases with an increase in percentage of FA.
- OMC increases with increasing percentage of RHA and MDD decreases with an increase in percentages of RHA.
- OMC decrease with increase in percentage of CCF and MDD increases with an increase in percentage of CCF.
- Maximum Dry Density was observed for black cotton soil mixed with 32% RHA, 6% FA and 0.6% CCF.

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