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EFFECT OF FLY ASH AND RBI GRADE 81 ON SWELLING CHARACTERISTICS OF CLAYEY SOIL

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Abstract: The thickness of road depends on geotechnical properties of subgrade soil and traffic intensity. The clayey soil is not suitable for subgrade due to its swelling characteristics. The soil having more liquid limit (LL), lower Maximum dry density (MDD) and higher Optimum moisture content (OMC) is suitable for subgrade of road. The clayey soil having more LL, lower MDD and higher OMC. Therefore clayey soil is not suitable as subgrade soil of roads. This paper deals with stabilization of clayey soil by using fly ash and RBI Grade 81 to improve the geotechnical properties of soil. The fly ash is a thermal waste and RBI Grade 81 is a chemical soil stabilizer. In the laboratory standard Proctor test (SPT), Atterbergs limits and differential free swelling index (DFS) test for different proportions of soil, fly ash and RBI Grade 81conducted. The results show that, the LL, MDD, OMC and DFS index of clayey soil improved considerably. The LL of untreated soil is 67% and it reduces to 46% for mix of soil: fly ash: RBI Grade 81 for 76:20:04 proportion. The DFS of untreated soil is 65% and it reduces to 40% for addition of fly ash and RBI Grade 81.

***Key Words**: DFS, Fly ash, Geotechnical properties, RBI Grade 81™, Soil stabilization.*

1. INTRODUCTION

Road network in rural areas plays important role in development of agricultural base country, like India. The life and maintenance of rural road depends on strength of subgrade soil and traffic intensity. The soil of the subgrade which satisfies the conditions given by IRC: SP: 72-2007 are suitable as subgrade soil. If the soil has CBR value less than 2%, it must be replaced by good quality material. If the subgrade soil is black cotton soil, the swelling and shrinkage effect is more due to variation of moisture in the soil. The construction of rural roads in black cotton soil is somewhat difficult and its cost of construction is more due to replacement of black cotton soil by good quality material. To overcome this difficulty, the black cotton soil can be stabilized with fly ash and RBI Grade 81.

The fly ash is used for stabilization of soil from longer time. The addition of only fly ash is not sufficient for subgrade soil stabilization. The RBI Grade 81 is an additive which helps to improve the geotechnical properties of black cotton soil. If the fly ash and RBI Grade 81 used together, the geotechnical properties of black cotton soil improved considerably. If fly ash used for stabilization, it helps to reduce the cost of construction as well as solve disposal problem of it, up to certain extent.

1.1 Review of literature

R.K. Sharma et al. [1] carried out studies on use of sand, rice husk ash and waste plastic fiber for improving compaction and strength characteristics of clay for use as subgrade material. The influence of different mix proportions of clays, sand, rice husk ash, on compaction and CBR values have been studied. The addition of rice husk ash in the clay and sand mix increases the OMC and decreases MDD. The addition of plastic fiber, rice husk ash and sand in the clay, leads to increase in the CBR value and reduction in permeability. Kolay, P.K. et al. [2] carried out study by addition of pond ash in soil in the range of 5%, 10%, 15%, and 20%. Based on their experimental study, it is found that the MDD for pond ash sample is increased, while the OMC decreases with increase in the pond ash content. The UCS test shows that the compressive strength for peat and pond ash mixed sample increases.

The compressive strength of peat-pond ash sample almost doubled in comparison with original peat soil with addition of 20% pond ash of weight of modified soil. To achieve economy in construction of road it is expected to use locally available material.

Aykut Senol et al. [3] based on their experimental work quantified the effect of fly ash stabilization on four different types of soft subgrades encountered using locally available fly ash in Wisconsin. For improvement in engineering properties of soils, a combination of lime and fly ash is beneficial for lower plasticity and higher silt content soils. The fly ash provides the pozzolanic reactants, silica and alumina, lacking in such soils.

It is beneath the flexible asphalt layer or rigid concrete layer. Joel H. Beeghly [4] carried out the studies by using lime with coal fly ash in stabilization of soil subgrade and granular aggregate base course observed that with UCS tests and CBR penetration tests, three soils of moderate plasticity and high silt content show that a lime fly ash mixture can achieve greater strength than lime alone.

2. MATERIALS

2.1 Soil

In the present study the soil sample is collected from Parli road, near Parli Thermal power plant in Beed district of Maharashtra state of India. The soil in this area is clayey soil. The various properties of soil are tested in the laboratory and results are as given in table 1.

Table 1: Basic properties of soil

Properties of black cotton soil	Value
Specific gravity	2.39
Liquid limit %	67
Plastic limit %	30.52
Plasticity index %	36.48
Maximum dry density g/cm^3	1.44
Optimum moisture content %	28.65
Silt and clay content % (below 0.075)	76.15
Sand content % (0.075 to 4.75 mm)	14.75
Gravel content % (4.75 to 80.0 mm)	9.10

2.2 Fly ash

After burning of coal in thermal power plant, about 80% of total ash is collected by electrostatic precipitator. This ash is called as fly ash or chimney ash. Fly ash consists of inorganic materials. The main content of fly ash are silica and alumina and some amount of organic material in the form of unburnt carbon The fly ash sample is collected from the Thermal Power Plant located at Parli, in Beed District of Maharashtra State of India. The basic properties of fly ash are as given in table 2.

Table 2: Properties of Fly ash

Physical parameters	Values
Color	Light gray
Gravel % (4.75 to 80.0 mm)	0
Sand % (0.075 to 4.75 mm)	82
Silt and Clay % (below 0.075 mm)	18
Specific Gravity	2.37
Plasticity Index	Non plastic

3. EXPERIMENTATION WORK

The basic properties of soil sample collected were found in the laboratory are as given in the table 1. The standard Proctor test (SPT) was carried out as per IS: 2720- 1980 (Part VII). The SPT was carried out on soil and different mixes of soil, fly ash and RBI Grade 81 and MDD and OMC found out. The differential free swell index found for soil and mixes of soil: fly ash: RBI Grade 81 for different proportion.

4. RESULTS AND DISCUSSIONS

The maximum dry density of untreated soil was found to be 1.45 g/cm^3 and OMC was 28.65%. The MDD for mix of soil: RBI Grade 81 for proportion of 98:2 and 96:4 was found to be 1.45 g/cm^3 and 1.46 g/cm^3 respectively. The OMC for mix of soil: RBI Grade 81 for proportion of 98:2 and 96:4 were found to be 26.16% and 25.90% respectively. The results of dry density and OMC for mix of soil: RBI Grade 81 for different proportions is given in table 3. Figure 1 shows the effect of RBI Grade 81 on dry density and OMC of soil. As compared to untreated soil, the modified soil mix of soil: RBI Grade 81 in the proportion of 98:2 led to MDD of 1.45 g/cm^3 but at reduced OMC. Similarly for mix of soil: RBI Grade 81 for proportion of 96:4, MDD obtained was 1.46 g/cm^3 and OMC was found to be reduced than untreated soil. It shows that due to addition of RBI Grade 81 the dry density increases and OMC decreases.

Table 3: Effect of RBI Grade 81 on dry density and moisture content of soil

M.C. in %	Dry density for untreated soil in g/cm^3	M.C. in %	Dry density for 2% RBI and soil g/cm^3	M.C. in %	Dry density for 4% RBI and soil g/cm^3
23.0	1.43	22.5	1.43	22.8	1.42
25.8	1.44	24.2	1.44	25.9	1.46
28.6	1.45	26.1	1.45	26.6	1.45
30.2	1.43	28.4	1.42	29.0	1.44

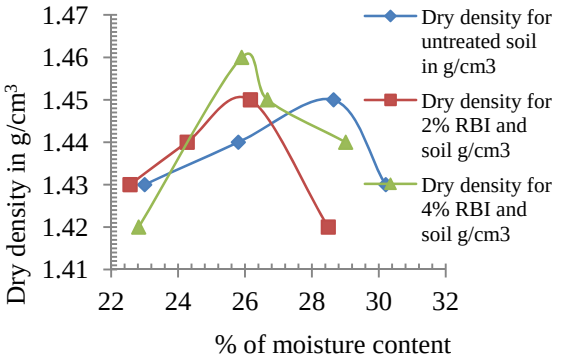

Figure 1: Effect of RBI Grade 81 on dry density of soil

The soil is treated with 2% RBI Grade 81 and different percentage of fly ash, the results are as given in the table 4. The results show that the dry density of mix soil: fly ash: RBI Grade 81 in the proportion 88:10:2 is increased and OMC decreases as compared to untreated soil. The dry density for mix of soil: fly ash: RBI Grade 81 in the proportion of 88:10:2 are found to be maximum and reduction in OMC is

observed in comparison with proportion 78:20:2. As the percentage of fly ash increases the dry density and OMC decreases.

Table 4: Effect of fly ash and 2% RBI Grade 81 on dry density of soil

M.C. in %	Dry density for untreated soil g/cm3	% of m.c. for 2% RBI and 10 % p.a.	Dry density for 2% RBI and 10% p.a.	% of m.c. for 2% RBI and 20 % p.a.	Dry density for 2% RBI and 20% p.a.
23.0	1.43	15.8	1.45	18.3	1.36
25.8	1.44	17.3	1.46	20.4	1.39
28.6	1.45	19.5	1.48	23.5	1.41
30.2	1.43	21.0	1.49	25.7	1.44
31.4	1.41	23.3	1.48	28.9	1.4

The soil treated with 4% RBI Grade 81 and 10% and 20% of fly ash. The results are shown in the table 8. Figure 4, shows the relation between dry density and moisture content. The values of dry densities for mix of soil: fly ash: RBI for proportion of 86:10:4 are reducing as compared to dry density of untreated soil. As the percentage of fly ash increases, the OMC was reduced as compared to untreated soil. For mix of soil: fly ash: RBI Grade 81for proportion of 76:20:4, the dry density decreases as compared to untreated soil.

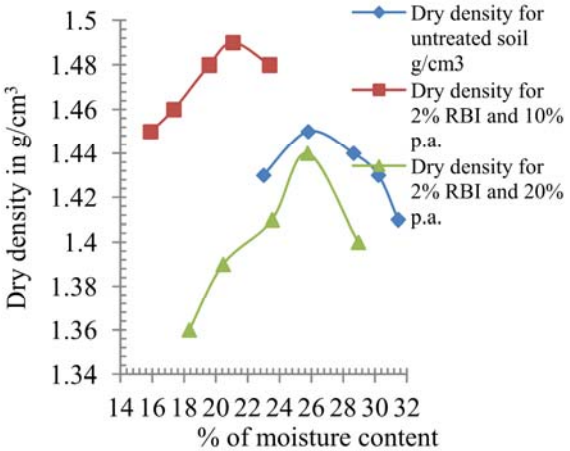

Figure 2: Effect of fly ash and 2% RBI Grade 81 on dry density of soil

Table 5: Effect of fly ash and 4% RBI Grade 81 on dry density of soil

M.C. in %	Dry density for untreated soil g/cm3	% of m.c. for 4% RBI and	Dry density for 4% RBI and	% of m.c. for 4% RBI and	Dry density for4% RBI and
		10% p.a.	10% p.a.	20% p.a.	20% p.a.
23.0	1.43	22.85	1.40	18.83	1.35
25.8	1.44	24.10	1.42	19.76	1.37
28.6	1.45	25.10	1.43	21.59	1.42
30.2	1.43	29.01	1.41	25.51	1.40
31.4	1.41	33.57	1.36	26.88	1.38

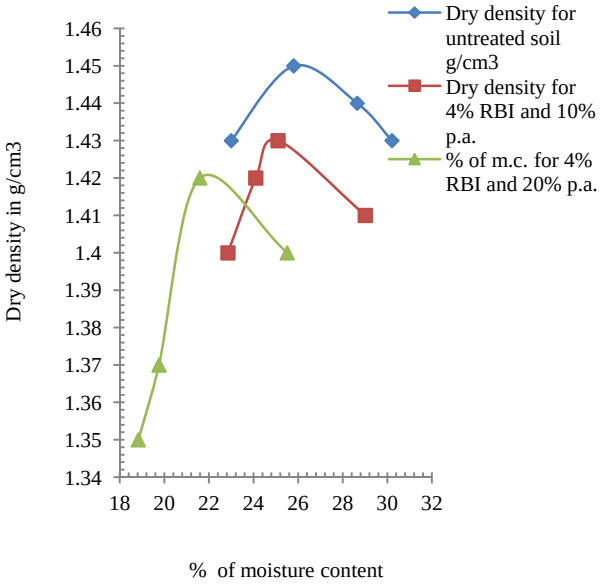

Fig. 3: Effect of fly ash and RBI Grade 81 on dry density of soil

Table 6: Effect of fly ash and RBI Grade 81 on CBR value of soil

Soil: pond ash: RBI Grade 81	Liquid Limit in %
100:00:00	67
98:00:02	58
96:00:04	53
90:10:00	60
80:20:00	55
70:30:00	48
88:10:02	56
78:20:02	47
68:30:02	42
86:10:04	52
76:20:04	46
66:30:04	40

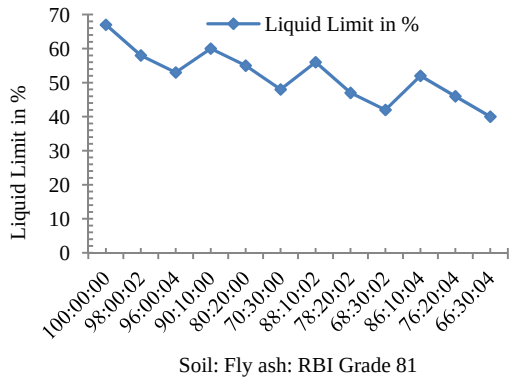

Figure 4: Effect of fly ash and RBI Grade 81 on liquid limit of soil

The differential free swell index test is carried on different proportions of soil, fly ash and RBI Grade 81 and the results are as given in the table 7. Figure 5 shows that the DFS of treated soil with fly ash reduces as compare to untreated soil. The DFS index of soil treated with fly ash and RBI Grade 81 reduces considerably as compared yo untreated soil. This reduction in DFS index of treated soil shows that the swelling characteristic of soil reduces.

Table 7: Effect of fly ash and RBI Grade 81 on DFS value of soil

Soil: Fly ash: RBI Grade 81	Differential free swell index in %
100:00:00	65
100:10:00	60
80:20:00	50
97:00:03	45
96:00:04	40
77:20:03	40
76:20:04	35

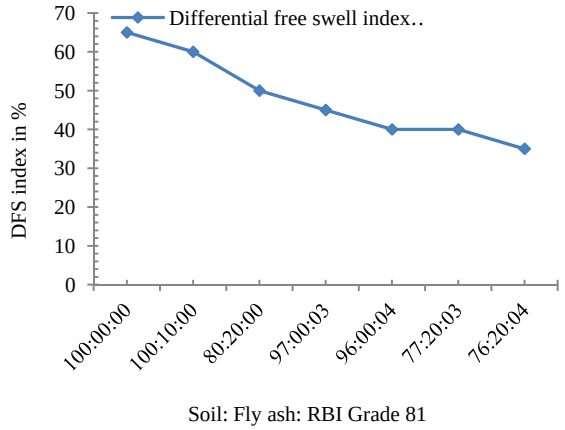

Figure 5: Effect of fly ash and RBI Grade 81 on DFS index of soil

5. CONCLUSIONS

Based on the experimental investigations carried out, different conclusions drawn are as given below.

1. The fly ash and additives RBI Grade 81 used for soil stabilization shows good improvement in properties of soil. The soaked CBR value also increases considerably.
2. For mix of soil: RBI Grade 81 in the proportion of 96:4, the MDD is found out to be 1.46g/cm^3. Addition of RBI Grade 81 in the soil, the variation in MDD is minimum but the reduction in OMC is considerable.
3. For mix of soil: RBI Grade 81 in the proportion of 96:4, the OMC is found out to be 25.90%. It shows that due to addition of RBI Grade 81, the OMC reduces as compared to untreated soil.
4. For soil: fly ash: RBI Grade 81 in the proportion of 80:20:0, the MDD is found to 1.47g/cm^3 and OMC 23.59%. For addition of fly ash in soil MDD increases up to 20% and decreases for 30%. Similarly the OMC decreases for addition of fly ash in soil.
5. For mix of soil: fly ash: RBI Grade 81 in the proportion of 88:10:2, the MDD is found to be 1.49g/cm^3 and OMC is 21.07%. The dry density of soil increases for 88:10:2 and after that it reduces for 78:20:2 proportions.
6. The important advantage of use of fly ash is that, it solves the problem of disposal of fly ash and protects the environment.

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