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Effect of Fly ash and RBI grade 81 on Geotechnical properties of Expansive soil

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Abstract - *This study deals with the improvement in various properties of expansive soil using soil stabilizer Road Building International(R.B.I.) grade 81 and locally available industrial waste material like fly ash. The additive like RBI Grade 81 and Fly ash is used to improve the properties of subgrade soil. The cost of construction of any civil engineering structure may increase, if only RBI Grade 81 is used as a stabilizer. The CBR value of subgrade soil can be improved by using fly ash with RBI Grade 81and cost of construction can be reduced to certain extent. From CBR test, it is found that the soaked CBR value of soil is improved by 635% i.e. 2% to 14.7% by stabilizing soil with 20% fly ash and 6% RBI Grade 81. The various mixes of clayey soil: fly ash: RBI Grade 81 for the different proportions were tested for maximum dry density (MDD), optimum moisture content (OMC) and unconfined compressive strength (U.C.S) values. In the present study, an attempt is made to modify engineering properties of a locally available soil from Jabalpur region, Madhya Pradesh India. The following tests were carried out on the untreated and stabilizer treated soil with varying Fly ash% as 0%, 10%, 15%and 20% and RBI81 as 0%,2%, 4% and 6%.*

Key Words: Expansive soil, RBI grade 81, Fly ash, U.C.S.

1. INTRODUCTION

Soil stabilization can modify one or more soil properties by various means to produce an improved soil system that will give appropriate stability to the design and also support the conditions throughout the design life of the project. Soil varies from place to places and their engineering properties are equally variable. Highway construction on cohesive/clayey soils has been a challenge to engineers and designers because of its high swelling and shrinkage characteristics due to presence of inorganic clays of medium to high compressibility, which results in deformations and cracks in the pavement structure. Well established mechanical and chemical stabilization techniques are often used to improve its engineering properties. The stability and performance of pavements are greatly influenced by the subgrade as they serve as foundations for pavements. A sub-grade soil must meet adequate strength requirements as per IRC -37 (2007). If not, there is a need to replace the natural soil by another soil with improved strength and compressibility characteristics or modify the existing soil to suit the requirements. The present study highlights the stabilization of low strength expansive soil with a stabilizer RBI Grade 81 with fly ash.

RBI Grade 81 is a light grayish powder, inert, chemically stable, eco-friendly and commercially available additive. It is durable, aesthetically pleasing, dust free surface and also hardens fast. Based on previous works and studies, it is found that strength of soil treated with RBI Grade 81 increases with age. In order to investigate the advantages of using RBI-81, and to understand behavior of expansive soil upon addition of fly ash with RBI 81, study was taken up with an expansive soil form Jabalpur region in Madhya Pradesh.

1.1 Literature review

Haricharan et al. (2013) evaluated the influence of RBI -81 stabilizers on properties of black cotton soil through laboratory investigation. Black cotton soil with varying percentages of RBI -81 viz 0, 0.5, 1, 1.5, 2 & 2.5 percent were studied for moisture density relationship and strength behavior of soil. In this experiment many several tests & analysis were made like Liquid Limit, Plastic Limit along with UCS & CBR. After conducting all the tests the author gets the result that UCS which treated with RBI-81 has increased up to 1032 KN/m^2 which was earlier 208 KN/m^2 after 28 days curing i.e. about 250% as compared to virgin soil. Further the CBR value improved approximately by 400% as the CBR value of virgin soil was 1.34% which has increased up to 14% after mixing 2.5% RB1-81 and 7 days curing period. Overall the plasticity index of the RB1-81 treated soil was found to be encouraging

Vinay et. al. (2011) investigated the strength properties for two types of soils. A local loamy soil and clayey soil were stabilized with RBI-81. Durability test, flexural strength, permeability test were carried out on untreated soils and soils treated with 1, 2, 4% RBI-81. A considerable increase in the strength values of CBR, UCS was reported.

Madurwar et al. (2013) made an attempt to modify engineering properties of black cotton soil by using RBI-81 and sodium silicate. After then Atterberg limit , CBR and UCS test were conducted out on the sample of soil with RBI-81 in proportion of 2% & 6% with curing period of 7,14 &28 days. Which finally made them to come to the conclusion that the normal soil which was having 2.33% CBR & 2.69% UCS has been increased to 10.03% & 3.62% at 14 days curing by adding 2% RBI-81 & 8.03% & 2.97% with 7 days curing. After then authors increased the percentage of RBI-81 from 2% to 4% which gave them result of 18.87% & 4.44% with 14 days curing and 16.24 % & 3.96% with 7 days curing.

Overall the final conclusion which has been made by them was that the UCS & CBR value increases with increase in RBI 81.

Sushant et. al (2010) carried out an investigation to study the influence of RBI Grade 81 and lime on the stabilization of blast furnace slag and fly ash. Standard proctor test and unconfined compressive strength test for different combinations of the stabilizing agents were conducted. It was concluded that UCS of stabilized sample increases with increase in the period of curing. But the percentage of increase in strength was more upon lime addition compared to addition of RBI-81.

Application of RBI Grade 81 chemical stabilizer causes the liquid limit to decrease and the plastic limit to increase, thereby decreasing the plasticity index of red soil under investigation. The most significant influence occurs mainly in the expansive soil than in the red clay soil studied by YOTAM Engineering Limited.

1.2 Objectives

The objectives of the present study are listed below :-

1. To evaluate the effect of RBI-81and Fly ash on the basic properties of soil.
2. To study the influence of Fly ash and RBI 81on Atterberg limits of the soil.
3. To calculate the effect of Fly ash and RBI 81 on CBR values of soil
4. To study the effect of RBI-81 and Fly ash on the unconfined compressive strength of the soil.

2. MATERIALS

After collecting soil samples, laboratory testing was done to assess the type of soil by evaluating its basic properties. Initially soil classification tests such as grain size analysis, liquid limit, plastic limit, plasticity Index were performed, followed by assessment of strength parameters such as compaction, California bearing ratio (CBR) and unconfined compressive strength (UCS). All the tests have been performed in accordance to Bureau of Indian Standards (BIS).

Table -1: : Basic Properties of Soil

Properties of Untreated Soil	Values
Specific Gravity	2.4
Liquid limit %	60
Plastic limit %	26
Plasticity Index	34
Maximum Dry Density	1.6
Optimum Moisture Content	26
California Bearing Ratio (%)	2
Uncofined Compressive Strength (Mpa)	0.1
Silt and Clay Content % (Below 0.075 mm)	98.53
Sand Content % (0.075 to 4.75 mm)	1.47
Gravel Content %(4.75 to 80 mm)	0

Similarly, the properties of stabilizer used here that is RBI grade 81 were studied as given in the manual provided by the Alchemist technology limited (2010),New Delhi. The properties are given in table 2.

Table -1: Basic Properties of RBI Grade-81

Properties	Values
Color	Grey Powder
Odor	Odorless
Specific Gravity	2.5
Self Life	12 Months
Propylene Fiber %(By Mass)	1

The Fly ash sample is collected from the Thermal power plant located at Birsingpur District Shahdol M.P. The basic properties of fly ash are given in table 3.

Table -1: Basic Properties of Fly Ash

Properties	Values
Colour	Light grey
Specific Gravity	2.32
Plasticity Index	Non-Plastic
Fine % (Below 0.075)	83
Coarse % (0.075 to 4.75 mm)	17

3. RESULT AND DISCUSSION:

Clayey soil + Fly Ash + RBI-81	Samples	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	CBR Value- 4 days soaked (%)	UCS Value- 4 days soaked (KN/m2)
Clayey soil + 0% + 0%	CF0R0	60	25.8	34.19	2	76.11

Claye y soil + 0% + 2%	CF0R 2	57	26.5	28.5	3.15	85.26
Claye y soil + 0% + 4%	CF0R 4	55	27.6	24.4	4.24	93.01
Claye y soil + 0% + 6%	CF0R 6	49	28	21	10.6	123.65
Claye y soil + 10% + 0%	CF10 R0	57	27.3	29.7	2.1	126.21
Claye y soil + 10% + 2%	CF10 R2	55.6	28.5	27.1	5	148.25
Claye y soil + 10% + 4%	CF10 R4	53	29.7	23.3	10.22	173.12
Claye y soil + 10% + 6%	CF10 R6	45	30.5	14.5	12.8	198.14
Claye y soil + 15% + 0%	CF15 R0	56	28.7	27.3	2.1	143.23
Claye y soil + 15% + 2%	CF15 R2	55	29	25	6.2	184.24
Claye y soil + 15% + 4%	CF15 R4	50	29.8	20.2	11.3	196.21
Claye y soil + 15% + 6%	CF15 R6	44.3	30.7	13.6	13.8	214.32
Claye y soil + 20% + 0%	CF20 R0	54	29	25	2.82	181.34
Claye y soil + 20% + 2%	CF20 R2	54.5	29.2	25.3	7.2	197.26
Claye y soil + 20% + 4%	CF20 R4	48	30.01	17.99	12.8	209.19
Claye y soil + 20% + 6%	CF20 R6	42.7	30.8	11.9	14.6	233.16

3.1 Atterberg limits: The Atterberg limits of untreated soil and the soil+ fly ash+ RBI 81 mixtures have been performed in accordance to IS 2720: Part 5. The results are summarized in table-4. The tests indicated an decrease in liquid limit and increase on plastic limit which resulted in marginal reduction in plasticity index showing a significant improvement in soil.

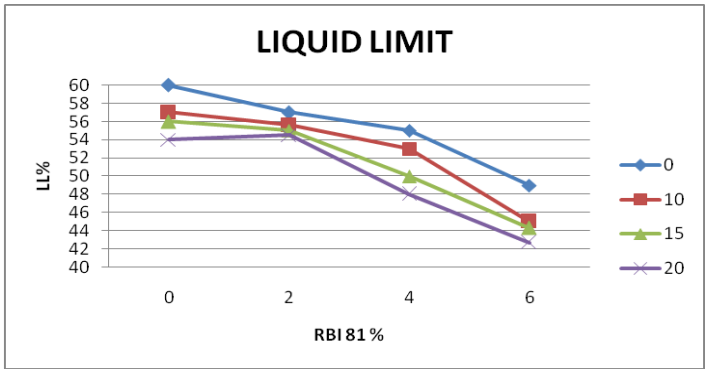

Chart -1: Effect of RBI81 and fly ash on LL% values in soil.

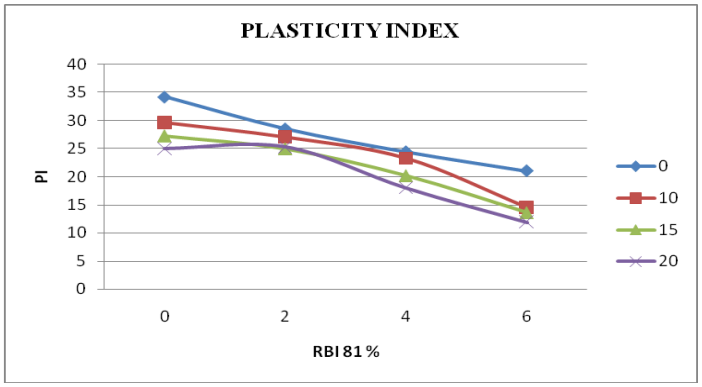

Chart -2: Effect of RBI81 and fly ash on PI% values in soil.

3.2 California Bearing Ratio: The test was performed in accordance with IS 2720: Part 16 and the results are summarized in Table 4. It can be observed that there is a significant improvement in CBR value after 4 days of curing. The increase in CBR value after four days duration of curing

was found to be approximately 635%, indicating suitability of mixes of R.B.I 81 and fly ash in road construction work. The CBR value of the untreated soil sample was 2% C.B.R. values for mix of soil: fly ash: RBI 81 for proportion of 78:2:20, 76:4:20 and 74:6:20 found to be 7.2%,12.8%, and 14.6%respectively. All the other values at different proportions are tabulated in Table 4 and graphs were plotted between proportions and C.B.R. values.

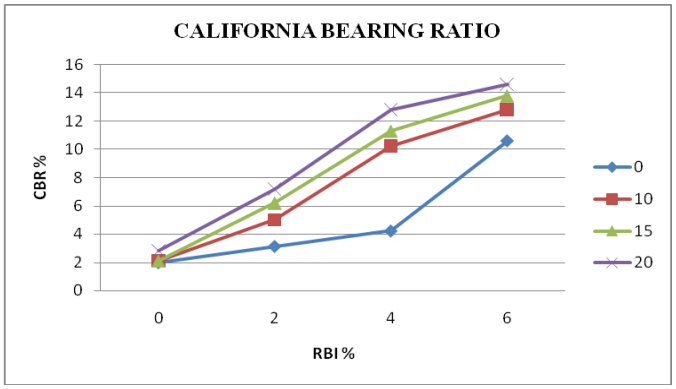

Chart -3: Effect of RBI81 and fly ash on CBR values in soil.

3.3 Unconfined compressive strength:

This test was performed in accordance with IS 2720: Part 10. The results on the effect of varied dosages of RBI 81 fly ash on Unconfined Compressive strength for a curing period of 4 days are summarized and presented in the Table 4. It was found that the changes in UCS were significant on addition of RBI 81 and fly ash content after 4 days of curing. Further increase in RBI content had no significant contribution in the UCS. The increase in UCS value was approximately 205%.

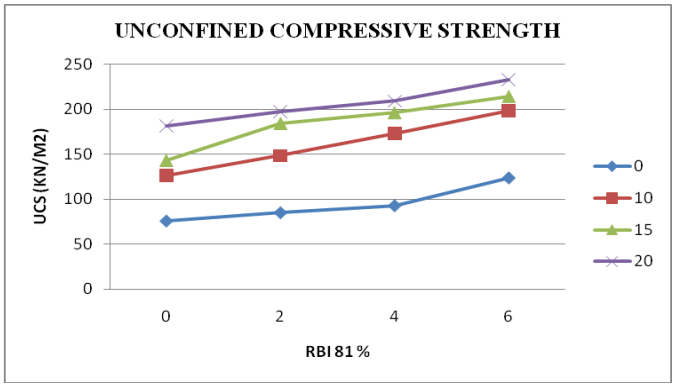

Chart -4: Effect of RBI81 and fly ash on U.C.S. values in soil.

4. CONCLUSION:

With the increase of fly ash and RBI 81 content in soil sample, the values of liquid limit reduces and considerable decrease occur in plasticity index of the treated soil, maximum dry density increases while optimum moisture content decreases and hence compactibility of soil increases and making the soil dense and hard. A significant increase of 205% and 635% in the values of UCS and CBR respectively are observed with the addition of Road Building International (RBI) grade 81 material in 0%, 2%, 4% and 6% proportion with fly ash in 0%,10%,15% and 20% variations mixed with given soil sample. The mixing of RBI 81 with fly ash will be recommended for cost efficient soil stabilization works.

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