The Comparative Study of Fly Ash & RBI Grade 81 on Lateritic Soil

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Abstract- In most of the failure cases, the soil does not have sufficient strength & bearing capacity to sustain under traffic load, natural disasters (earthquake, heavy rain, flood, and landslides), and structure. So, attempt is to modify & improve the properties of Lateritic Soil by adding fly ash, RBI Grade 81, bottom fly ash etc. Fly ash & RBI Grade 81 materials are used where fly ash is industrial waste or by-product & RBI-81 stand for Road Building International which is a soil stabilizer. To check the influence of fly ash & RBI-81 on index & engineering properties, we have performed laboratory tests regarding core cutter method, oven dry method, sieve analysis, density bottle test, liquid limit, and plastic limit also MDD, compaction test, triaxial test, CBR tests with the help of available laboratory equipments. RBI-81 & Fly Ash are used in varying percentages from 1% to 5% by weight at optimum percentage of water. Hence, we concluded that the 4% of fly ash, 3% of RBI Grade 81 and 2% of combined sample fly ash & RBI Grade 81 are found to be appropriate in order to achieve the objectives of our project i.e. to improve properties and bearing capacity of locally available lateritic soil. In present investigation, we have obtained optimum percentages of fly ash and RBI Grade 81 required for sub-base regarding IRC recommendation. From graphical representation, Fly Ash sample gives increment in CBR value by 13.62% than untested soil sample, whereas RBI-81 shows 26.49% & combination sample gives 24.69% increment in CBR value. By observation, it can be concluded that addition of RBI-81 has found to be greater in % of improvement value than fly ash and combination sample. Therefore, RBI-81 is more economical than Fly ash & combination sample (fly ash+RBI-81). From above summary, we can conclude that addition of Fly Ash & RBI Grade 81 on lateritic soil has improved its properties resulting improvement in soil's bearing capacity.

Indexed Terms- Bearing capacity, CBR, Fly ash, Lateritic soil, MDD, RBI Grade 81, and stability.

I. INTRODUCTION

Soil is fundamental element to build any structure. It gets changes in its properties from region to region due to weathering actions; hence, it is necessary to adopt suitable type of methodology & technology at the time of construction. It possesses index and engineering properties which are responsible for its nature & behavior under certain action of load. In many failure cases, soil is unable to sustain after its maximum bearing capacity is utilized.

Lateritic soil has very low plasticity, high moisture content and high permeability due to which it forms difficulties in construction. Hence, it is necessary to modify or stabilize its properties. It can be strengthened or improved by adding supplementary materials or stabilizers. Fly ash & RBI Grade 81 are used as supplementary materials to get improvement in bearing capacity of lateritic soil; whereas, fly ash is industrial waste product. In India, it is produced in tons per year. However, the disposal problem of fly ash is covered.

To check the effects of fly ash & RBI-81 on lateritic soil suitable experimental work is required. But following the title of study, results are needed to be compared, concluded and represented on the basis of improvement & economical aspect.

II. MATERIALS USED

A. lateritic soil:
Commonly considered to have formed in hot and wet tropical areas develop by intensive and prolonged weathering of the underlying parent rock. Found in Karnataka, Kerala, Tamil Nadu, Madhya Pradesh and the hilly areas of Orissa, Assam and Konkan region etc.

B. Fly Ash:
It is generated during the combustion of pulverized coal in the thermal power plants and waste product of chemical industry. Here, F-class fly ash is used.

C. RBI Grade 81:
It is eco-friendly, inorganic, powder based soil stabilizer which is non-UV degradable & inert. It is a road construction material patented worldwide. It is a cementitious powder material form which is grey in color, also acts as waste binding.

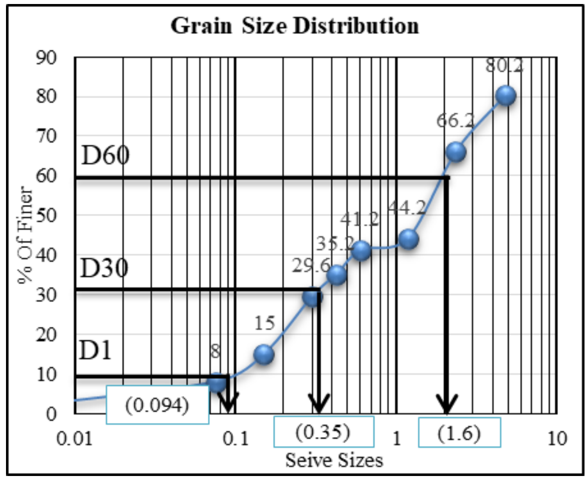
III. METHODOLOGY

The soil sample having undisturbed properties was collected from site. The soil sample was subjected to go under various tests for further analysis regarded by IS-code: 2720 for selection of methodology. We have done some experimental work; the assembly is as follows:

A. Core Cutter Method:
This method was used to determine the dry density of sample (*lateritic soil*). Density is defined as the mass per unit volume of soil. For present sample, procedure was followed as per recommendations mention in IS-code: 2720, Part 5 and dry density of locally available soil was resulted.

B. Oven Drying Method:
This method was used to determine moisture content of sample (*lateritic soil*). For present sample, procedure was followed as per recommendations mention in IS-code: 2720, Part 4 and moisture content of locally available soil was resulted.

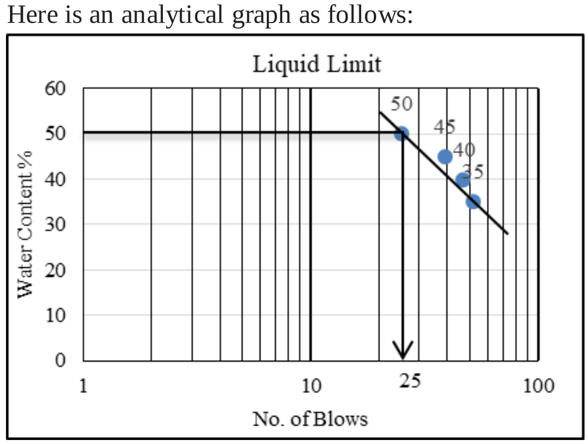
C. Grain Size Distribution:
Sieve analysis was done to identify the classification of soil whether it is well graded or poorly graded soil. As per IS-code: 2720-Part 6, we have made an analysis & plotted a grain size distribution curve showing gradation of soil where the result is depending upon the value of coefficient of curvature and uniformity coefficient. The grain size distribution curve is represented as follows:



D. Density Bottle Method:
This method was used to calculate specific gravity of soil, procedure followed by IS-code: 2720, Part 7.

E. Liquid Limit:
This test was used to determine the liquid limit of sample (*lateritic soil*). This is the limiting moisture content at which the cohesive soil passes from liquid state to plastic state. This was found by following IS-code: 2720, Part 11.

Here is an analytical graph as follows:



F. Plastic Limit:
The plastic limit test of a soil was used to determine the moisture content, expressed as a percentage of the weight of the oven dry soil procedure followed by IS-code:2720, Part-11.

G. CBR Test:
The California Bearing Ratio (CBR) test is a penetration test used to evaluate the subgrade strength of roads and pavements followed by IS-code: 2720, Part 16. This test is done on the *lateritic soil* with addition of fly ash & RBI grade 81, combination of both and without addition of both materials. A standard metal rammer (IS: 9198-1979) is used for compaction.

- Preparation of Sample :

i. Lateritic Soil Sample :
1. Take about 3.2 kg of lateritic soil and mixed with the 17% of water.
2. Fix the extension collar and the base plate to the mould. Insert the spacer disc over the base. Place the filter paper on the top the spacer disc.
3. Compact the mix soil in the mould using light compaction. For light compaction, compact the soil in 3 equal layers, each layer is being given 56 blows by 2.48 kg rammer remove the collar and trim off soil.
4. Turn the mould upside down and remove the base plate and the displacer disc. Weight the mould with compacted soil (collar side) and clamp the perforated base plate on to it.
5. Place the mould assembly with the surcharge weights on the penetration test machine. Seat the penetration piston at the center of the specimen with full contact of the piston on the sample is established. Set the stress and strain dial gauge to read zero.
6. Apply the load on the piston so that the penetration rate is about 1.25 mm/min. Records the load readings at penetrations of 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5 & 5.0 mm.

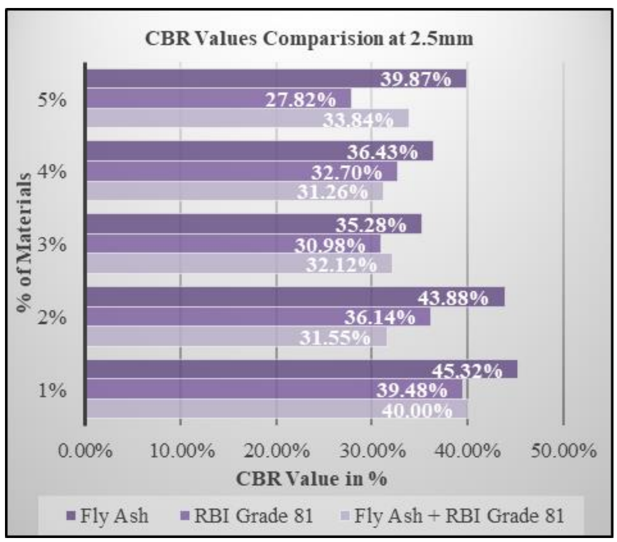
ii. Lateritic soil + Fly Ash Sample:
1. Take about 3.2 kg of lateritic soil and 1% of Fly ash in addition of 17% of water content; mix them well.
2. Follow 2, 3,4,5,6 steps for further procedure.
3. Follow above procedure for 2%, 3%, 4%, and 5%. Above procedure was followed for Lateritic soil+RBI-81 samples where for combination sample (lateritic soil + fly ash + RBI-81) rest of procedure remains same excepts % of water that becomes 15% and there is contribution of 1% from fly ash and RBI-81 each.

H. Proctor Compaction Test (MDD):
This method covers the determination of the relationship between the moisture content and density of soils compacted (2.5kg rammer dropped from a height of 30cm). MDD was determined as per IS-code: 2720, Part 8.

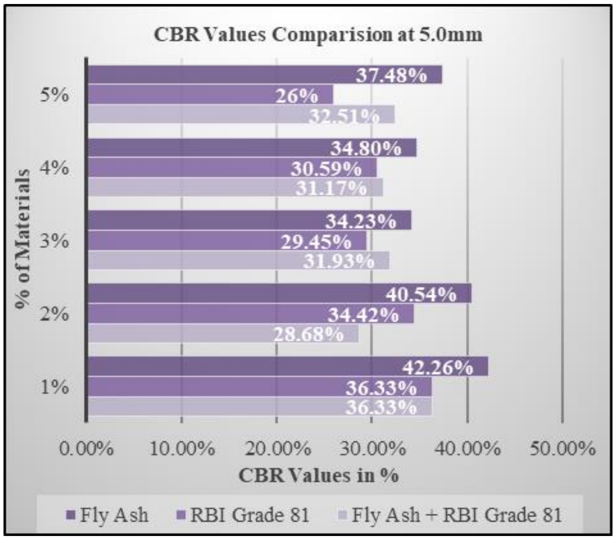
I. Triaxial Shear Test:
The triaxial compression test is more commonly used in laboratory for determination of shear strength. Test is followed by IS-code: 2720, Part 11.

On the basis of experimental work, all the result summery is represented in table no.1 & 2 also, the comparative representation is done for analysis purpose as follows:

Graphical Analysis:
Graph no.1: Corresponding bar chart shows comparative representation of CBR values in percentages from 1% to 5% of each three samples tested at 2.5mm penetration,



Graph no.2: Corresponding bar chart shows comparative representation of CBR values in percentages from 1% to 5% of each three samples tested at 5.0mm penetration,



IV. RESULT

From all experimental work, a tabular summery is as follows which consists of two tables corresponding results from index properties. The remark claims conditions or description of output.

Table 1: Results for Index Properties (a)

Sr. No.	Particulars	Quantities with units	Type of method	Remark	IS Codes
1.	Dry Density of Soil (ρ_d)	1.26 gm/cc	Core Cutter Method	-	IS 2720 Part 5
2.	Moisture Content (W)	33.33 %	Oven Dry Method	-	IS 2720 Part 4
3.	Grain Size Distribution	C_c = 0.81 C_u = 17.02	Sieve Analysis	It is well graded medium uniform sandy soil group sand.	IS 2720 Part 6
4.	Specific Gravity (G)	2.11	Density Bottle Method	-	IS 2720 Part 7
5.	Liquid Limit	50 %	Liquid Limit Test	-	IS 2720 Part 11
6.	Plastic Limit	33.33 %	Plastic Limit Test	-	IS 2720 Part 11

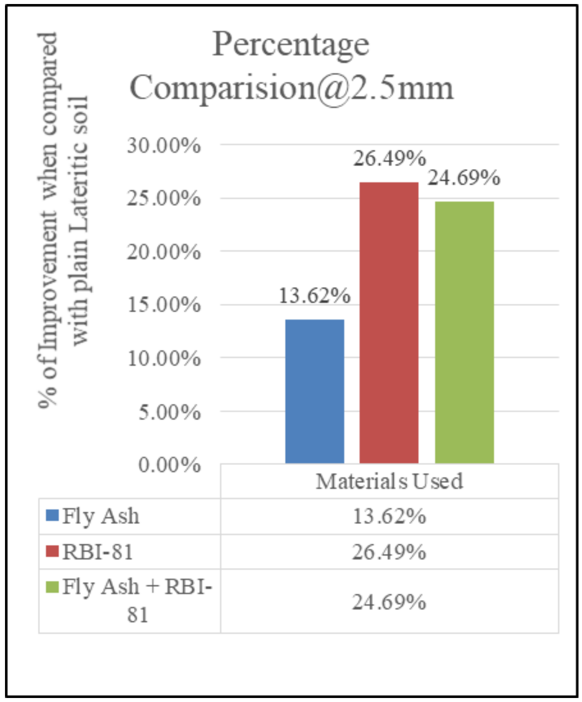
In following table, CBR results are finalized on basis of IRC recommendation or on specific conditions from all of samples of varying percentages compared in bar representation in statistical analysis.

Table 2: Testing Result based on Engineering Properties (b)

	CBR	2.5 mm	5.0 mm			
7.	a) Laterite only	40.44%	37 %	CBR Test	Soil range without addition of material	IS 2720 Part 16
	d) Laterite + Fly ash	36.43%	34.80%		Here, swelling effect is considered.	

	c) Laterite + RBI Grade 81	30.98%	29.45%		CBR values between 20% -30 % are accepted here as per IRC recommendation for sub-base.	
	c) Laterite + Fly ash + RBI Grade 81	31.55%	28.68%			
7.	Maximum Dry Density (MDD)	1.856 gm/cc		Proctor Compaction Test	-	IS 2720 Part 8
8.	Triaxial Shear Test	C=6.8 KN/m^2 $Ø=29^0$		Triaxial Shear Test	-	IS 2720 Part 11

Comparative Representation of Results:
Graph 3: Percentage Comparision@2.5mm
It is a Graphical representation of samples Fly Ash, RBI Grade 81 and combination of fly ash & RBI Grade 81 based on difference of percentages at which composition is found to be most improved from 1% to 5% taken at 2.5mm; in which Fly Ash has CBR value improved by 13.62% than plain soil sample, whereas RBI-81 shows 26.49% & combination sample gives 24.69% as shown by following graph,



V. DISCUSSION

From all results obtained by performing laboratory test, we can successfully aim objectives of our project. We are able to compare CBR values and find out which sample has comparatively more improved % of CBR value which shows bearing capacity of soil has improved. We have studied effect of fly ash and RBI-81 on lateritic soil. We can say that, properties of lateritic soil are improved.

CONCLUSION

1. From above test results, we can conclude that the mixing of Fly Ash & RBI Grade 81 in lateritic soil has improved its properties.
2. In present investigation, we have obtained optimum percentages of fly ash and RBI Grade 81 required for sub-base regarding IRC recommendation.
3. From the CBR results, optimum value for fly ash is recorded to be 35.28% for 4% @2.5mm penetration when compared to results at 1%, 2%, 3%, 4%, 5%.
4. From the CBR results, optimum value for RBI Grade 81 is recorded to be 30.98% for 3% @2.5mm penetration when compared to results at 1%, 2%, 3%, 4%, 5%.

5. From the CBR results, optimum value for combined sample Fly ash & RBI Grade 81 is recorded to be 31.55% for 2% @2.5mm penetration when compared to results at 1%, 2%, 3%, 4%, 5%.
6. Hence, we concluded that the 4% of fly ash, 3% of RBI Grade 81 and 2% of combined sample fly ash & RBI Grade 81 are found to be appropriate in order to achieve the objectives of our project i.e. to improve properties and bearing capacity of locally available lateritic soil.
7. From graphical representation, Fly Ash sample gives increment in CBR value by 13.62% than untested soil sample, whereas RBI-81 shows 26.49% & combination sample gives 24.69% increment in CBR value. By observation, it can be concluded that addition of RBI-81 has found to be greater % of improvement value than fly ash and combination sample.
8. Therefore, RBI-81 is more economical than Fly ash & combination sample (fly ash+RBI-81).

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