



STUDY ON ALKALI ACTIVATED FLY ASH FOR STABILIZATION OF BLACK COTTON SOIL

Mr. PRAVEEN KUMAR P¹ KAVYA T M²

¹Assistant Professor, GSKSJTI, BENGALURU-560001

²Department of Civil engineering, GSKSJTI BENGALURU-560001

Abstract: The Stabilization of Expansive soil has a great importance now days and several methods and materials have been suggested for effective stabilization of these expansive soils, This analysis presents the stabilization of a local expansive soil using alkali activated fly ash. First the basic properties of black cotton soil are found out, the fly ash of different percentages such as 10, 20, 30, 40 and 50% are blended with black cotton soil and optimum dosage was found out, The activated fly ashes at different alkali concentrations 0, 0.5, 1, 1.5 and 2 molarities are used to perform tests. Different geotechnical properties like Atterberg's limits, compaction, CBR and UCS of stabilized expansive soil were tested. It was observed that there is a considerable improvement in geotechnical properties of expansive soil with the addition of alkali activated fly ash and the results of alkali activated fly ash are found more suitable than normal fly ash mix.

Keywords: Expansive soil, alkali activated fly ash, compaction, Atterberg's limits, CBR, UCS.

I. INTRODUCTION

The process of obtaining the desired strength of soil by using additives as a stabilizer is known as stabilization of soil, in chemical stabilization several chemicals are used to enhance the engineering properties of the soil, it may not overcome the demand on the non renewable sources but this method is cost effective.

Chemicals like sodium chloride, sodium silicate, Calcium chloride, Calcium carbonate and potassium hydroxide are used in chemical stabilization. The engineering characteristic of the soil is enhanced by alkali activated fly ash, in this present study i have used potassium hydroxide (KOH) as chemical it is basically from alkaline group, this is used with fly ash to form alkali activated fly ash. Now a day's alkali activated fly ash obtained from the many industries. It is the emerging concept how to increase the strength of the soil by using the alkali activated fly ash. It works like cement in the construction site due to its synthetic and expensive and ecological factor. It is the cement for the future use. It helps to transfer glassy structure to the compact good cemented composite in the chemical process. In case of this mineral in the chemical process powdered alumina-silicate and fly ash mixed with alkaline as an additive and produce product like paste which has a capacity of setting and firstly hardening within a short interval of time. Alkali activated fly ash was eco-friendly and has a capacity of good binding so it was used as an stabilizer to increase the strength for the project work based on the work and the place of work.

II. OBJECTIVE OF THE STUDY

- To find the basic properties of black cotton soil.
- To find the optimum moisture content, maximum dry density and optimum dosage of fly ash and alkali activated fly ash.
- Finding out CBR and UCS value for black cotton soil with fly ash and alkali activated fly ash.
- Comparison of results and Inference of the above Tests.

III. LITERATURE REVIEW

"Stabilization of black cotton soil by Fly Ash" by Ashish Mehta et.al (2013) ⁽¹⁾. In this paper suggested that, problem faced by civil engineers at the construction site there are only two option remove the soil and treated with good additive to improve the soil stabilization. Study area taken as Maharashtra, India at different locations. Fly ash obtained at near location in the Koradi Thermal Power Plant was used as additive at different percentage of concentrations. Plasticity of fly ash was nearly zero when mixed with clay is the main objective. The result obtained by this is workability increases due to colloidal reactions and also changing in the grain size of soil, and plasticity decreases. CBR values obtained by this shows after the addition of fly ash in the condition of unsoaked and soaked fly ash was a good potential as an additive.

"Stabilization of Black Cotton Soil using Alkali Activated Fly Ash" by Prashant Hiremath et.al (2016) ⁽²⁾. In this paper using the additive as sodium based alkaline activators with fly ash to improve the stabilization of soil. By various percentage of fly ash as used in the experiment related with the total solids. NaOH concentration of two molar was an activator. Parameters like Atterberg's limits, compaction and compressive strength were carried out. The result was found

that liquid limit and plasticity was decreases and increases in the plastic limit of soil. Graph was plotted on OMC and MDD after the addition of fly ash as an additive. Graph shows the increase in concentration of OMC decreases MDD. When percentage of fly ash increases unconfined compression strength. Activator increases also curing period.

“Stabilization of Black cotton soil of class-F fly ash as an additive” by Pandian et.al (2001) ⁽³⁾. In this paper study was performed out on the CBR behavior of black cotton soil and Raichoor fly ash (which is class F) in layers and compared with the same in mixes, Several studies have been carried out for bulk utilization of fly ash, such as its addition of fly ash to improve the California bearing ratio (CBR) of soil in roads and embankments. But a thorough mixing of fly ash with soil may not be possible in the field; the results show that the CBR values of soil-fly ash mixes are better than the soil fly ash with layers. Cement is used as a additive to fly ash for improve the strength of layers. The results show that black cotton soil can be improved with stabilized fly ash, solving its strength problem as well as the disposal problem of fly ash.

“The effect of fly ash on engineering properties of expansive soil”, by Phani Kumar and Sharma (2007) ⁽⁴⁾. Fly Ash India, 2007, this note presents a study of the efficiency of fly ash as an additive in improving the engineering characteristics of black cotton soils. An experimental program has evaluated the effect of the fly ash content on the free swell index, swell potential, swelling pressure, plasticity, compaction, strength, and hydraulic conductivity characteristics of expansive soil. The plasticity, hydraulic conductivity and swelling properties of the blends decreased and the dry unit weight and strength increased with an increase in fly ash content, for given water content the resistance to penetration of the blends increased significantly with an increase in fly ash content, excellent correlation was obtained between the predicted and measured undrained shear strengths.

“Effect on Engineering properties of Black Cotton Soil by Alkali Content Sodium Hydroxide” by Rajesh Jain and Dharmendra Sahu et.al (2016) ⁽⁵⁾. In this paper was reported that by using NaOH as an additive which is not environment effective and less time consuming. The main objective is that to improve the stabilization of soil in the engineering projects by considering the parameters like OMC, compressive strength, MDD, cohesion etc. Study was carried out at Archa village at Jabalpur. From the 0.5m depth from the surface of the Earth NaOH was mixed to the soil at various percentages and simultaneously increasing in the concentration it shows the shear strength, compression strength and also angle of internal friction was increasing. Increase the concentration of NaOH decreases in the cohesion.

“Stabilization of Expansive Soil Using Alkali Activated Fly ash” by Sarat Kumar Das and Partha Sarathi Parhi et.al (2013), ⁽⁶⁾. In this paper suggested that to improve the stabilization of expansive soil by using different materials and methods, silica and alumina and alkali cations react and form materials in same way sodium and potassium have same molecular level as natural rocks. To improve mechanical characteristics higher than cement using alkaline activated materials. This explains about the how to improve the stabilization of a soil using fly ash with alkali activated. Fly ash with different alkali percentages and potassium hydroxide and also fly ash ratios tested. Geotechnical properties are also tested to the soil they are Atterberg’s limit, strength and compaction. Finally observed that there was a increase in the stabilization of soil by using activated fly ash.

“Study on Performance of Chemically Stabilized Expensive Soil” by Udayashankar et.al (2012) ⁽⁷⁾. in this paper it was reported that Stabilization of Black Cotton Soils Using Fly Ash, Hubballi-Dharwad Municipal Corporation Area, Karnataka, India, it helps in the scenario implementation of construction projects like highway, water tank, air strips and reclamation etc. Continuously growing cities like Hubballi and Dharwad they are tier-2 cities next to Bangalore. Large amount of Black cotton soil concentrates in this area so by studying the properties of the soil and which method is suitable also studied. Dandeli fly ash treatment to the Black cotton soil to their index, geotechnical properties like compaction and strength are increased. Liquid limit, plastic and also shrinkage limit are also come under favorable values. By the addition of fly ash shrinkage limit increases and liquid limit and plastic limit decreases. Optimum dry density decreases with increase in maximum dry density. Finally observed that increased in the values of California bearing ratio and compressive strength.

“Stabilization of Black Cotton Soils Using Fly Ash” by Venkara Muthyalu et.al (2012) ⁽⁸⁾. in this paper it reported that Study on Performance of Chemically Stabilized Expensive Soil was reported that black cotton soil is susceptible and volumetric change in nature by addition of water (water moisture). Soil attributed in the presence of Montmorillonite it has expanding lattice. Expansive soil characteristic has been studied by geotechnical engineers and it was found that how to increase the stabilization of soil. An electrolyte treated with the soil is the one of the best method to improve the stabilization of soil. After the influence of electrolyte (potassium chloride) and calcium chloride to the soil increase the stabilization and strength.

IV. METHODOLOGY

The following steps are adopted for the present study:

- The soil samples are brought from site.
- Basic properties of soil are finding out by conducting suitable test as per codal provision and obtained results are compared with standards.
- The optimum dosage of fly ash is found out by conducting compaction, CBR and UCS tests.
- Alkali activated fly ash is then added to the soil in different molarities (2mol) and the CBR, UCS tests are performed on same, and then results were compared.

V. LABORATORY INVESTIGATIONS

TABLE1. Properties of black cotton soil

SL. NO	PROPERTIES	CODE REFERRED	STANDARD VALUE	OBTAINED VALUE	REMARKS
1	Specific gravity	IS 2720(Part3)-1980	2.6 to 2.75	2.63	Satisfactory
2	Maximum dry density(MDD)	IS 2720(Part7)-1980	1.3 to 1.8gm/cc	1.62 g/cc	Satisfactory
3	Optimum moisture content(OMC)	IS 2720(Part7)-1980	20 to 35%	22%	Satisfactory
4	Free swell index	IS2720(Part40)-1977	40 to 180%	107.40%	Satisfactory
5	Liquid limit	IS 2720(Part5)-1985	40 to 120%	65.10%	Satisfactory
6	Plastic limit	IS2720(Part5)-1985	20 to 60%	25.36%	Satisfactory

TABLE2. CBR test results for various percentages of fly ash

SL. NO	FLY ASH IN (%)	CBR IN (%)
1	0	1.79
2	10	5.7
3	20	9.4
4	30	14.3
5	40	13
6	50	12.6

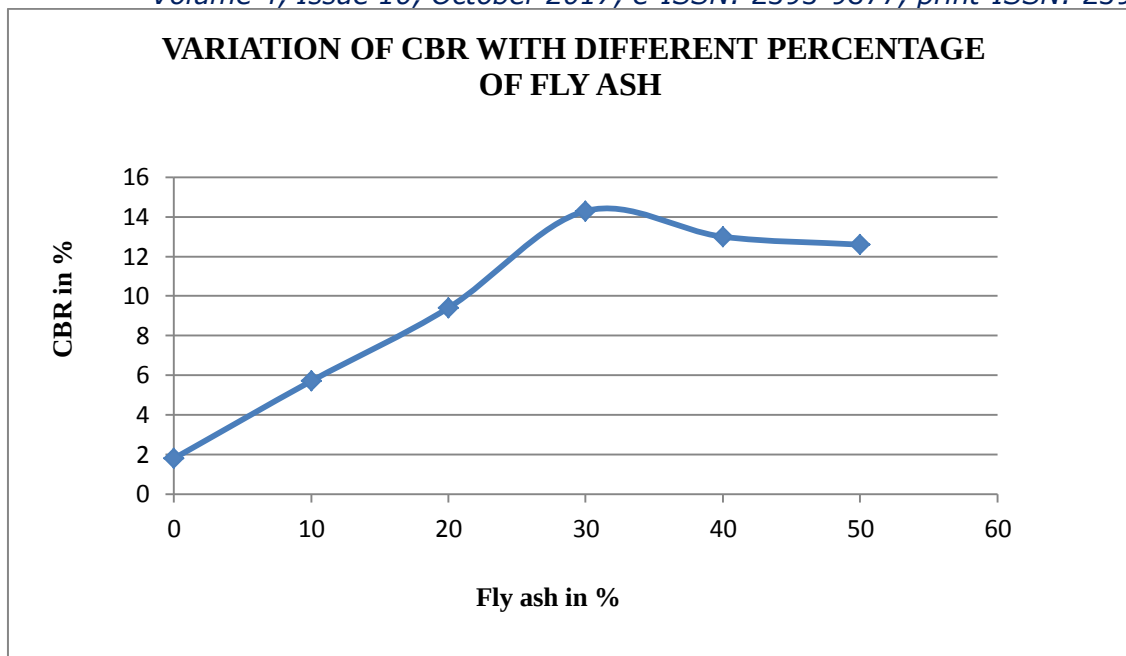


Figure 1 Variation of CBR with different percentage of fly ash.

TABLE3. Variation of Atterberg's limits with KOH

SL. NO	ADDITIVES IN (mol)	LIQUID LIMIT IN (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)
1	0	64.61	26.14	38.47
2	0.5	63.75	27.98	35.77
3	1	62.24	28.36	33.88
4	1.5	61.79	29.5	32.29
5	2	60.26	30.48	29.78

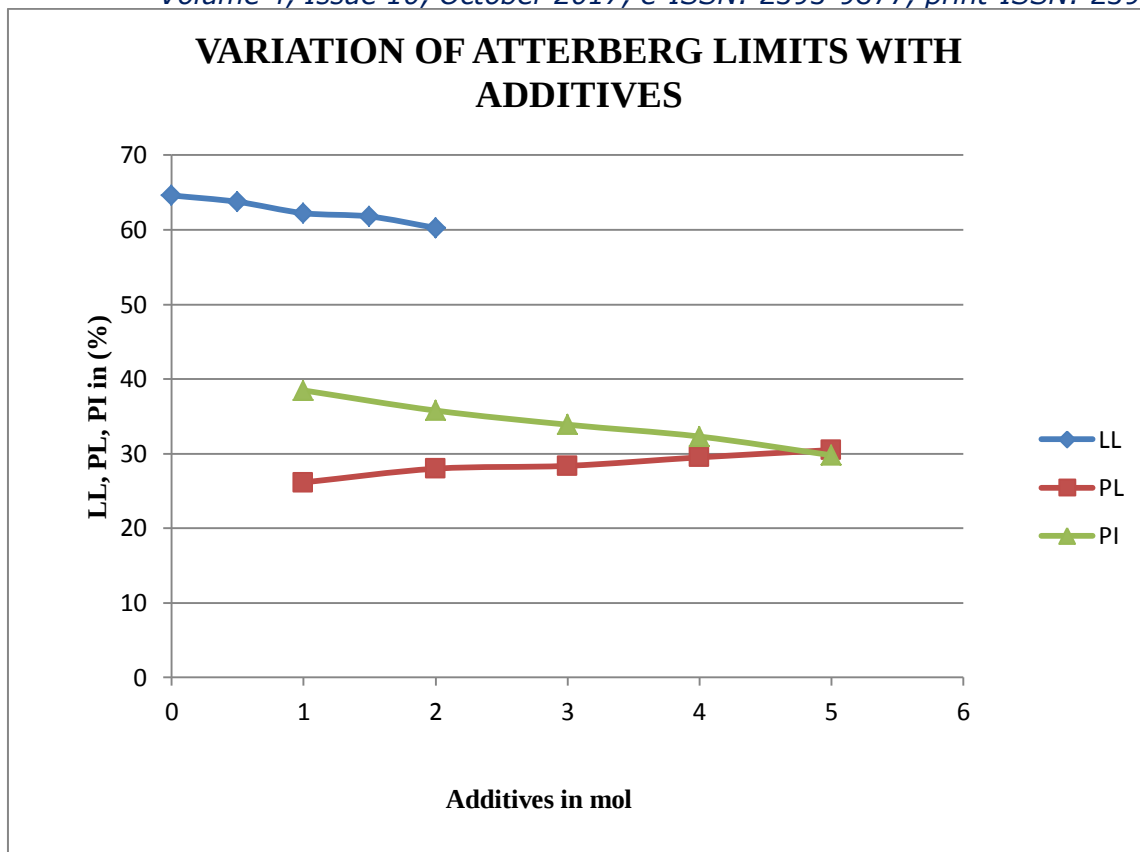


Figure 2 Variation of Atterberg's limit with additives

TABLE4. CBR test results for 2.5 and 5mm penetration for black cotton soil+ AAFA of different molarities

SL. NO	ADDITIVE IN (mol)	CBR IN %	
		AT 2.5MM PENETRATION	AT 5 MM PENETRATION
1	0	13.77	14.3
2	0.5	15.1	15.19
3	1	17.75	16.25
4	1.5	17.48	18.54
5	2	18	19.43

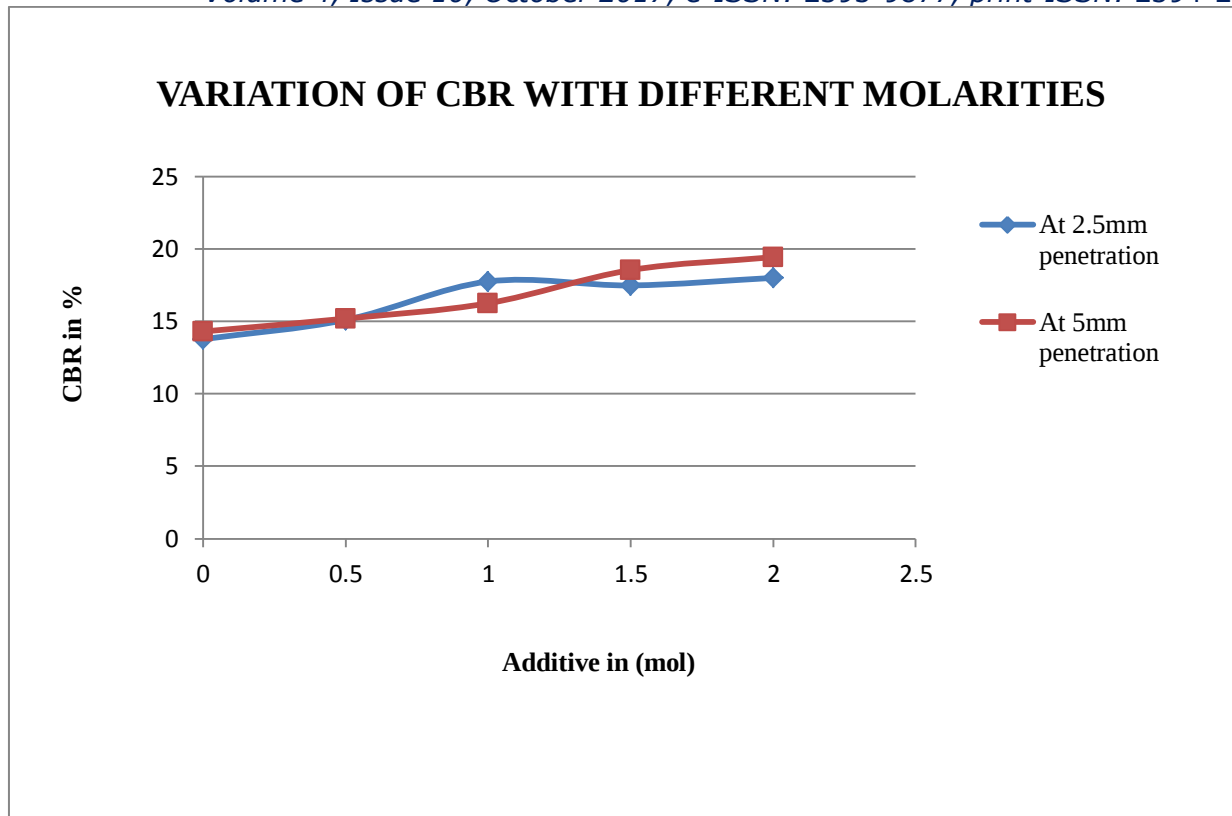


Figure 3 Variation of CBR with different molarities.

TABLE5. Variation of stress with different curing periods

SL. NO	AAFA IN (mol)	STRESS IN (N/cm ²)		
		0 DAYS	7 DAYS	14 DAYS
1	0	9.05	15.04	22.06
2	0.5	9.82	15.62	22.85
3	1	10.45	19.08	24.57
4	1.5	11.79	22.7	28.36
5	2	15.52	26.25	30.28

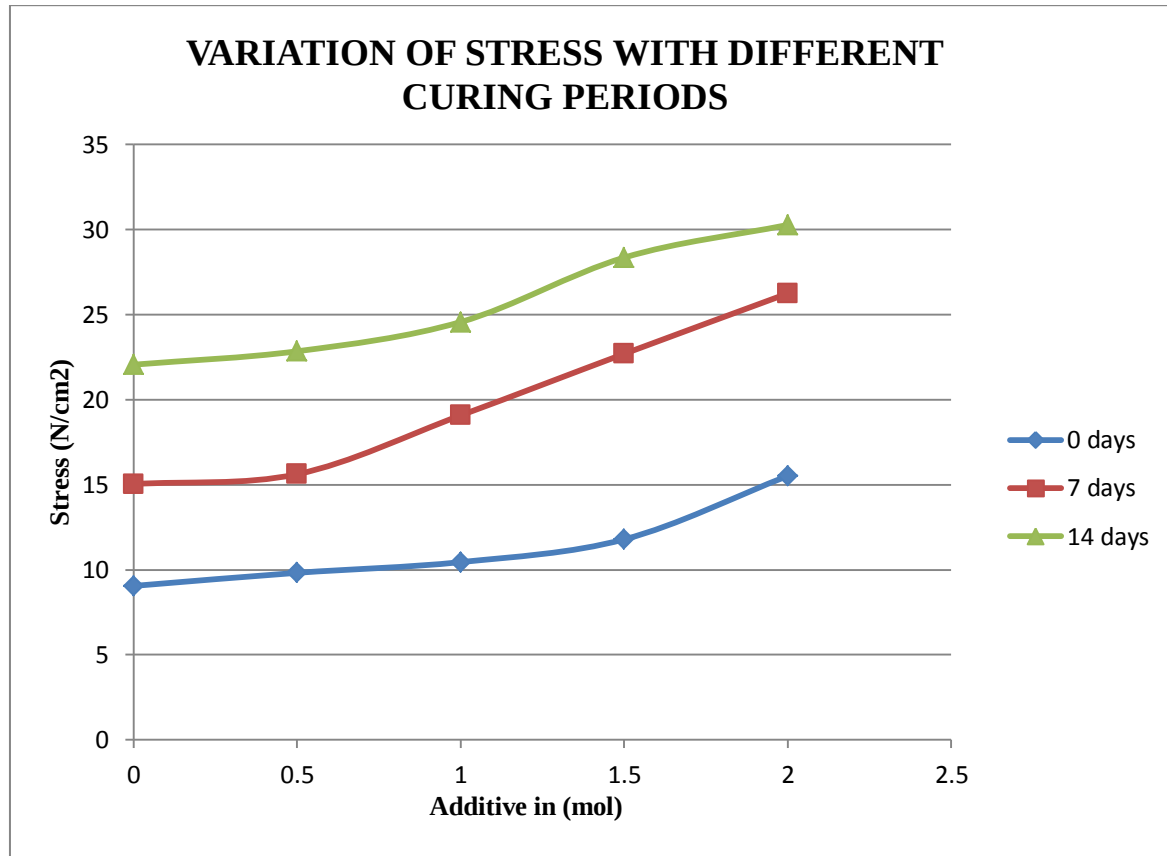


Figure 4 Variation of stress with different curing periods.

VI. CONCLUSION

- 1) The basic properties of black cotton soil, B.C soil with fly ash are, B.C soil with AAFA obtained are,
 - a) Liquid limit values: 65.1%, 64.61%, 60.26 %.
 - b) Plastic limit values: 25.36%, 26.14%, 30.48%.
 - c) Plasticity index values: 39.74%, 38.47%, 29.78%
 - d) Free swell index of black cotton soil is= 107.4%
 - e) The specific gravity of the black cotton soil is 2.63.
- 2) Proctor test the results obtained are,
 - a) The optimum moisture content and maximum dry density for black cotton soil is 22% and 1.62 gm/cc respectively.
 - b) The optimum moisture content, and maximum dry density, optimum dosage for black cotton soil with fly ash are 30%, 1.82gm/cc and 30%. Respectively.
 - c) The optimum moisture content, optimum dosage and maximum dry density for black cotton soil with AAFA are 30%, 1.95gm/cc, 2molarity respectively.
- 3) CBR and UCS results:
 - a) The CBR and UCS values for black cotton soil are 1.79%, 11.05 N/cm².
 - b) The CBR and UCS values for black cotton soil with fly ash are 14.3%, 21.06 N/cm².
 - c) The CBR and UCS values for black cotton soil with AAFA are 19.43%, 30.28 N/cm².

4) Conclusion

- a) From test results it is observed that the moisture content, maximum dry density values increased by 36.36% and 12.34 % with addition of fly ash.
- b) For black cotton soil with AAFA the OMC, MDD increased by 36.36% and 20.3% respectively. The CBR, UCS values increased 698.8% and 90.58% with the addition of fly ash and it increased by 985.47% and 174.02% with the addition of Alkali Activated Fly Ash.
- c) It can be conclude that, the CBR and UCS values increases drastically with the addition of Alkali Activated Fly ash when compared with Fly ash added to the Black Cotton Soil.

VII. REFERENCES

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1. Liquid limit test



2. Plastic limit test



3. Potassium hydroxide flakes



4. Mixing fly ash with black cotton soil