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INFLUENCE FLY ASH ON CHEMICALLY STABILIZED COHESIVE SOIL

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Abstract:

Clayey soils exhibit antagonistic characteristics such as low strength, swelling and shrinkage etc. In order to improve the engineering properties the common method pursued is stabilization. In the present project, experimentation is carried out to investigate the influence of additives such as Fly ash and Potassium Chloride on Compressive strength, California Bearing Ratio of the clayey soil. The two additives are added and the tests are carried out by keeping the proportions of Fly ash and Potassium Chloride as constant (30% and 1%). The Index properties are analysed for control sample and also with constant proportions of KCl (1 %), fly ash (30%) and combination of KCl and Fly ash (30% and 1%). The results show substantial improvement in CBR value, Compressive strength and the Shear strength of composite containing Fly ash, Potassium Chloride (30% : 1%). Hence the inclusion of Fly ash and Potassium Chloride can be effectively used for pavement sub-grade strength improvements.

Key Words: Clayey Soil, Fly Ash, Potassium Chloride, Shear Strength, Compressive Strength & California Bearing Ratio

1. Introduction:

For decades, many investigations are going on to improve the problematic characteristics of clayey soil such as low strength, swelling and shrinkage. From these investigations it is known that the stabilization process is the economical and effective method to improve the properties of clay. Soil stabilization is the alteration of soils to enhance the soil properties. Stabilization can increase the shear strength of the soil and/or control the shrink-swell properties of the soil thus improving the engineering and the index properties of the soil. The current research is to examine the influence of two additives namely fly ash and potassium chloride on the strength of clay. The purpose of using this additives are as follows: (1) Fly ash is added to increase the compressive strength and the CBR value of the soil. (2) Potassium chloride is added to increase the shear strength and decrease the swelling nature of the soil. Many studies have been conducted relating to the behaviour of the soil stabilized with each additives mention above.

2. Materials Used:

A. Clay: The soil used for this study was collected from a site near Villankurichi- Ganapathy, Coimbatore, Tamilnadu. The sample was obtained from a depth of 1.5m below the ground level. The moisture content of the fresh sample was also found out. The sample was thoroughly natural dried at room temperature.

B. Fly Ash: The fine residue from coal burning plants which is collected in a field is known as fly ash and considered as a waste material. The ASTM D 5239 classifies fly ash into three categories. In this project fly ash of Class F is used. The specific gravity of fly ash used in the experimentation is 1.936.

C. Potassium Chloride: The potassium Chloride of commercial grade is taken into this study. The quantity of the chemical added to the clayey soil was a constant of 1% by dry weight of soil.

3. Laboratory Investigation:

The clayey soil was dried naturally in room, impurities like any cloth, papers and other debris are removed. Then the soil is pulverized for the purpose of using it to determine the properties. The index properties of the soil were studied in the laboratory. The soil was tested for liquid limit, plastic limit, shrinkage limit, compaction characteristics, UCS, CBR value, shear strength and free swell. The properties are listed in Table-1. From the Atterberg limits, the soil is classified as clay of medium compressibility (CI) as per IS: 1498- 1970.

Table 1: Properties of Soil

Properties	Value
Specific Gravity	2.614
Percentage of clay Percentage of silt	40% 34.8%
Liquid limit	48.5%
Plastic limit	20%
Shrinkage limit	30.99%
Maximum Dry Density	1.715 g/cm^3
Optimum Moisture Content	20.6%
Unconfined compressive Strength	1.254 Kg/cm^2
California Bearing Ratio Values At 2.5 mm penetration	2.358 1.991

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At 5 mm penetration	
Free Swell	45%

The percentage of clay in the soil sample obtained from the site is determined by using sieve analysis and hydrometer analysis. The following graph shows the particle size distribution of the control sample.

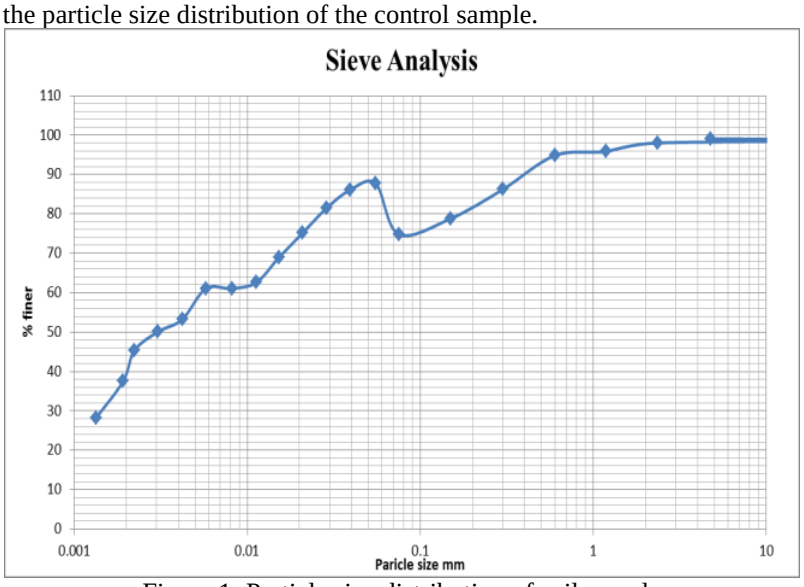

Figure 1: Particle size distribution of soil sample

For the control sample, control sample with 1% potassium chloride and control sample with 30% fly ash the following tests are conducted. The tests are Standard Proctor Test, Unconfined Compressive Strength Test and California Bearing Ratio Test. In addition to these test, Atterberg limits and free swell for control sample, control sample with 1% potassium chloride and control sample with 30% fly ash and 1% potassium chloride were determined.

4. Results and Discussion:

A. Atterberg Limits: The liquid limit, plastic limit, shrinkage limit and free swell values of control sample, control sample with 1% potassium chloride and control sample with 30% fly ash and 1% potassium chloride are as follows.

Table 2: Atterberg limits

Proportions	Liquid Limit %	Plastic Limit %	Shrinkage limit %	Free Swell %
Control sample	48.5	20	30.99	30
Control sample with 1% KCl	44.5	40	34.38	5
Control sample with 1%KCl and 30% Fly ash	35.5	50	21.0	-

B. Standard Proctor Results: Compaction characteristics were studied by conducting standard proctor tests. The tests were carried out on the samples for varying proportions of mixers as mentioned under tests carried out in order to determine the Optimum Moisture Content and the Maximum Dry Density.

Table 3: MDD and OMC values of soil for different mixes.

Proportions			Standard Proctor Test	
	KCl	Flyash	OMC (%)	MDD (g/cm^3)
Soil	-	-	20.6	1.715
	1%	-	18.1	1.723
	1%	30%	13.2	1.729

From the above table it is evident that the Maximum Dry Density increased when KCl and Fly ash are added. In contrast the Optimum Moisture Content decreased when KCl and Fly ash are added.

C. Unconfined Compressive Strength: The UCS test is carried out to determine the unconfined compressive strength of soil. The tests were carried out on the samples for varying proportions of mixers in order to determine the unconfined compressive strength.

Table 4: Unconfined Compressive strength values of soil for different mixes.

Proportions			UCS test
Soil	KCl	Flyash	Kg/cm^2
	-	-	1.254
	1%	-	1.580
	1%	30%	1.325

The above table is evident that the 1 % of KCl addition increases the Compressive strength & 30 % of Fly ash addition decreases the strength

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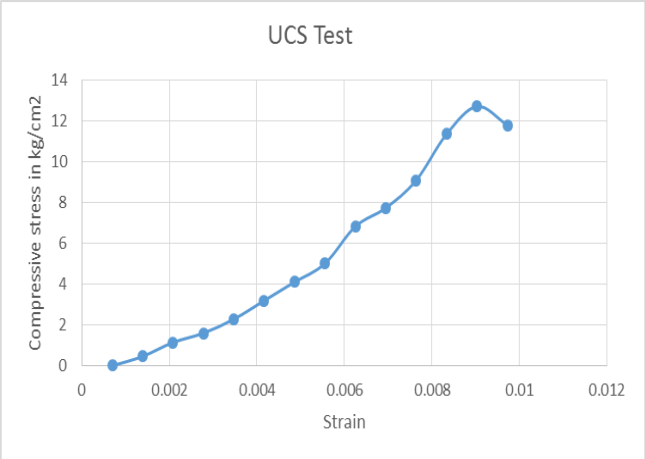

Figure 2: UCS Test Result – Control Sample

The above graph shows the UCS test result for cohesive soil taken for the Stabilization

D. California Bearing Ratio Test: The California bearing ratio test is used to determine the mechanical strength of the soil by finding the penetration at 2.5 mm and 5mm. The tests were carried out on the samples for varying proportions of mixers.

Table 5: CBR values of soil for different proportions

Proportions			CBR value	
Soil	KCl %	Fly ash %	At 2.5mm penetration	At 5mm penetration
	-	-	2.358	1.991
	1	-	1.651	3.248
	1	30	4.716	5.056

From the table 5, it is evident that the California bearing ratio is increasing with the addition of 30 % Flyash, 1 % kcl and both the Fly ash & KCL in the mentioned ratio (30% : 1%)

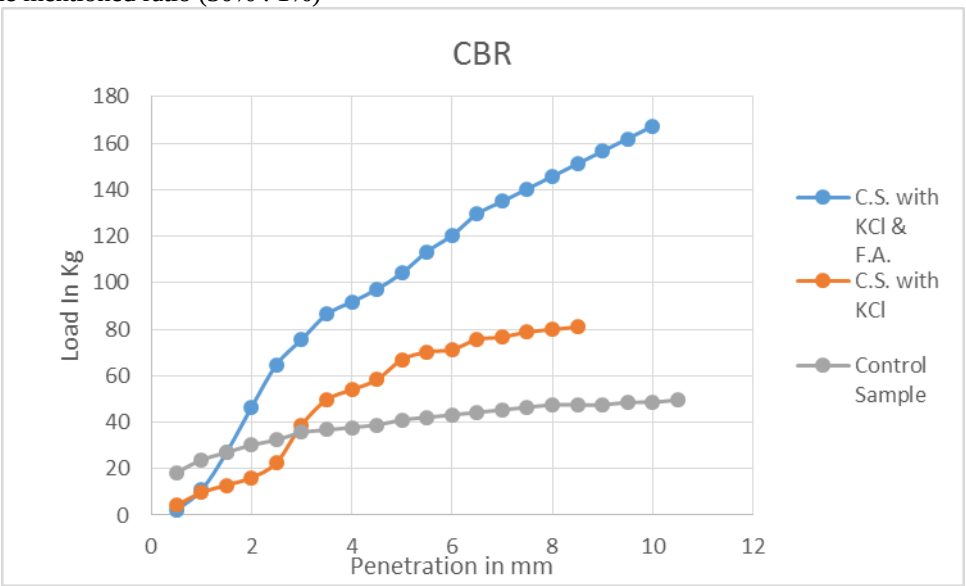

Figure 3: Comparison of CBR values

From the above graph it is evident that 1% KCl and 30%fly ash with the sample is the optimum to get high CBR value at 5 mm penetration.

5. Conclusion:

The study focused on the comparison of OMC, MDD, UCS and CBR value for sample with constant proportion of KCl , Fly ash and both fly ash & KCl (1% & 30%) for clay soil stabilization. By conducting various tests and determining various parameters mentioned above, it is concluded that the combination of Fly ash and KCl in the cohesive soil stabilization will improve the plastic limit values & decreases Shrinkage limit and Liquid limit values. In Compaction Parameters, additives (KCl & FA: 1%: 30%) increases Optimum moisture content & maximum dry density. It is found that 1 % of KCl alone increases the CBR value and UCS value about 63% & 26 % respectively; when 30 % of Flyash addition in chemical added clay exhibits 16% loss in the UCS value and 56 % improvement in CBR value.

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