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INFLUENCE OF ADDITIVES ON SEPIOLITE

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Abstract - *The soil strength and its characteristics can be improved by mixing it with various additives. Sepiolite is a naturally occurring clay mineral. The additive is mixed with sepiolite at various percentages and properties such as specific gravity, pH, Atterberg limits, compaction characteristics, UCC, and permeability are studied. In this study the sepiolite is mixed with two different additives, fly ash and kaolinite. The fly ash is added to the sepiolite with 2%, 4% and 6% and the variation of properties are found out. 25% and 50% Kaolinite is mixed with sepiolite and variation of properties is studied. The improvement in the soil properties are reported with additives content. Consistency limits were decreased with the increase of additive content. The compaction curve moved towards left with addition of additive. For sepiolite fly ash mixture the 7-day UCC strength is improved by 48%. For sepiolite kaolinite mixture the 7-day UCC strength is improved by 33%.*

Key Words: **Sepiolite, properties, fly ash, kaolinite**

1. INTRODUCTION

The geotechnical engineering has a great role in engineering. The soil strength and its characteristics are improved by mixing it with various products. The various external substances added to the soil is generally named as additive. The additive is generally added to improve soil properties. The generally soil is improved for better strength and hydraulic property. The strength property is improved for the sub base, embankment and filling purposes. The hydraulic properties are investigated for the embankment, liner properties. The sepiolite is a clay mineral which is also called meta montmorillonite because of its swelling property.

1.1 LITERATURE REVIEW

In recent years, the lack of availability of natural clays with satisfactory engineering properties has prompted researchers to look for alternative approaches for liner design. This motivation has led to the development of soil-like geomaterials to replace compacted clays. Various alternative geomaterials such as sand-bentonite mixtures, foundry sand, coal fly ash, municipal solid waste fly ash, and fly ash amended tire rubber have been investigated to determine if they would be applicable as landfill liner materials (Garlanger et al. 1987; Chapuis et al. 1992; Gleason et al. 1997; Palmer et al. 2000; Cokca and Yilmaz 2004; Abichou et al. 2004). Previous studies showed that these Materials can be viable alternatives to compacted clays, and can provide significant cost savings if the material is nearby cheap and transportation is not required. (Abichou et al. 2004). However, these alternative geomaterials may also exhibit some characteristics that would not be desirable in landfill design. For instance, bentonite-amended sands permeated with chemical solutions and landfill leachate were reported to exhibit significantly higher hydraulic conductivity than the hydraulic conductivity of same mixtures permeated with water (Alther 1987). Mitchell and Madsen (1987) and Jo et al. (2001) reported that several factors, including valence of cation, concentration of the salt solution, and the pH of the medium, affect hydraulic conductivity of bentonite. Increase in valence and concentration as well as a decrease in pH cause major increases in the hydraulic conductivity of bentonite and turn it into an ineffective liner material. Similar effects of chemicals on bentonite were reported by other researchers (Petrov et al. 1997)

2. MATERIAL USED

Sepiolite belongs to the phyllosilicate group of clay minerals with a 2:1 ribbon structure. It is composed of continuous and two-dimensional tetrahedral layer composition and discontinuous octahedral layers. Octahedral layer discontinuity leads to the formation of internal channels in the structure, which provides high absorptive capacity. Sepiolite collected for this study was from, Aastra Chemicals Pvt. Ltd. Chennai. The chemical composition of the sepiolite used in this study is given in the table 1. The initial properties of sepiolite is given in table 2.

Table 1: Chemical Composition of Sepiolite

Contents	Max	Min
Silica, SiO_2	56	58
Ferric Oxide, Fe_2O_3	-	0.25
Calcium Oxide, CaO	-	0.75
Magnesium Oxide, MgO	28	30
Loss on Ignition	7	8
pH of 5% Slurry	8	8.5

Table 2: Initial Properties of Sepiolite

SL NO:	PROPERTY	VALUE
1	Specific gravity	2.95
2	Liquid limit (%)	56.5
3	Plastic limit (%)	19
4	Plasticity index (%)	19.5
5	Shrinkage limit (%)	12
6	IS classification	CH

7	OMC (%)	32.3
8	MDD (KN/m^2)	15.07
9	% Clay	64
10	% Silt	40
11	% Sand	0
12	Activity	0.325
13	UCC strength (KN/m^2)	41.9
14	permeability (m/s)	6.325*10^{-10}

Kaolinite clay: The kaolinite clays are 1:1 phyllosilicates. The origin group is Orthoclase Feldspar. It is commonly referred to as "China Clay". Kaolin is a white, soft, plastic clay mainly composed of fine-grained plate-like particles.
The study was conducted on processed kaolinite clay which was brought from English India Clay limited (EICL), Trivandrum. The initial properties of kaolinite is given in table 3.

Table 3: Initial Properties of Kaolinite

SL NO:	PROPERTY	VALUE
1	Specific gravity	2.5
2	Liquid limit (%)	32
3	Plastic limit (%)	20
4	Plasticity index (%)	12
5	Shrinkage limit (%)	16.9
6	IS classification	CL
7	OMC (%)	28.57
8	MDD (KN/M2)	15.77
9	% Clay	66
10	% Silt	20
11	% Sand	4
12	Activity	0.09
13	UCC strength (KN/m2)	41.4
14	Permeability (m/s)	6.65x10-7

Fly ash: Fly ash is a major industrial waste product which is produced by the burning of powdered coal or other material carried into the air with presence of oxygen. It is also known as flue ash. The fly ash collected for this study is collected from the industries of Tuticorin.
The composition of Class – F fly ash collected for this study is shown in table 2.

Table 4: chemical composition of Class F

Compound	Fly ash class F
SiO_2	55
Al_2O_3	26
Fe_2O_3	7
CaO	9
MgO	2
SO_3	1

3. METHODOLOGY

Detailed experimental study is undertaken to investigate the characteristics and behavior change of sepiolite with the addition of fly ash and kaolinite in various proportions. Basic geotechnical laboratory testing was performed to establish the index properties of the clay mixture. Basic geotechnical properties test such as specific gravity, grain size distributions, swell tests, water content determination, Atterberg limits, UCC, pH and compaction tests were conducted to assess the behaviour of soil mixture.
The fly ash content is mixed with the sepiolite in percentages of 2%, 4%, and 6 % by weight. 10%, 25% and 50% kaolinite is added to the sepiolite. The huge amount is taken because kaolinite is basically inert in nature.

4. RESULT AND DISCUSSION

ADDITION OF FLY ASH WITH SEPIOLITE

Specific Gravity: Specific gravity showed a negative trend with the addition of the fly ash to the sepiolite. The specific gravity value decreased with addition of fly ash.

pH: With addition of the fly ash the soil shows a positive trend in pH. The pH value increased with addition of fly ash.

Table 5: Variation of pH And G

Kaolinite (%)	0%	2%	4%	6%
G	2.95	2.9	2.86	2.8
pH	8.5	8.58	8.69	8.74

Consistency limits: The affinity towards water and the water holding is represented by this consistency limits. The consistency limits show a negative trend, which means the reduction of Atterberg limit with the addition of the percentage increase of fly ash in it. chart 1 showsvariation of Atterberg limits with various percentages of fly ash with sepiolite.

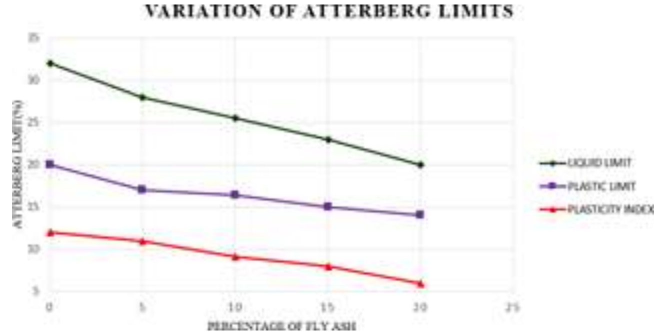

Chart -1: Variation of Atterberg limit.

Compaction: The sepiolite is mixed with 2% of fly ash to 6% fly ash is subjected to the standard compaction. The optimum moisture contentvalue decreases with the addition of the fly ash. Increase of fly ash content in the soil show lesser affinity towards water, this cause reduction in optimum moisture content.

Maximum dry density shows a very little or flat variation with the addition of fly ash in the soil. This is because the fly ash is non plastic in nature. The compaction curves of sepiolite and various percentages of fly ash is shown in chart 2.

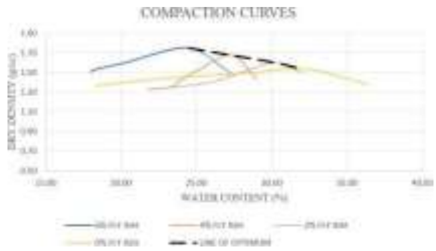

Chart -2: Compaction Curve of Fly Ash with Sepiolite

UCC: The maximum value of strength obtained was for 4% of fly ash with addition with sepiolite is shown in chart 3. The 7th day compressive strength is tested after curing. The strength improved 1.48 times than the zeroth day.

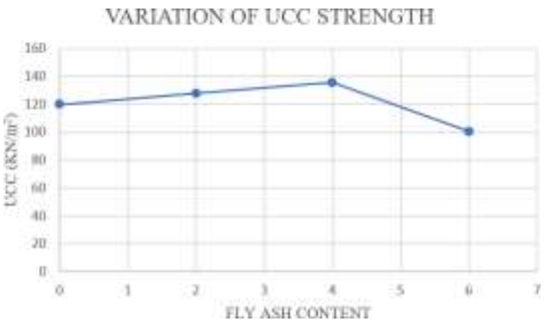

Chart -3: Variation of UCC of fly ash

Permeability: it is major property of the soil, which gives an idea about the seepage through the soil. The permeability is improved upto 4% addition of fly ash, after that it shows a negative trend.

ADDITION OF KAOLINITE WITH SEPIOLITE

Specific Gravity: Specific gravity showed a negative trend with the addition of the fly ash to the sepiolite.

pH: With addition of the kaolinite the soil shows a negative trend in pH. With increasing content of kaolinite the soil become more alkaline nature**.**

Table 6: Variation of pH And G

Kaolinite(%)	0%	25%	50%
G	2.95	2.74	2.65
pH	8.5	8.1	7.21

Consistency limits: The consistency limits show a negative trend the Atterberg limit reduces with increase of kaolinite content in sepolite. Chart 4 shows the variation of consistency limits.

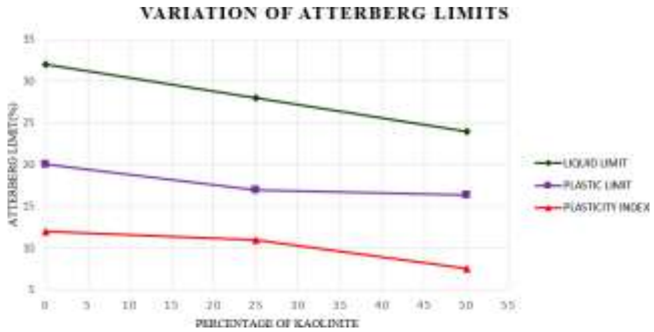

Chart 4: Variation of Atterberg limit with kaolinite content

Compaction: The optimum moisture content value decreases with the addition of kaolinite with it. With increase of kaolinite content in the soil will show lesser affinity towards water so at less water content the soil will show maximum dry density. Maximum dry density shows positive trend with the addition of kaolinite in the sepiolite. Chart 5 shows the compaction curves of sepiolite with various percentages of kaolinite.

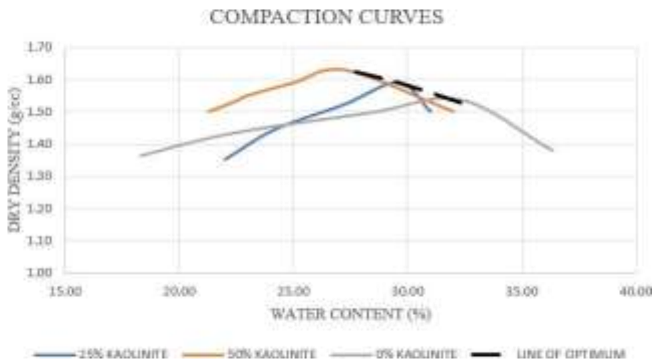

Chart -5: Compaction curves

UCC: The more kaolinite content soil will cause reduction in the strength because of kaolinite is less capable of taking strength, is shown in chart 6. The 7th day compressive strength is tested after curing. The strength improved 1.33 times than the zeroth day compressive strength.

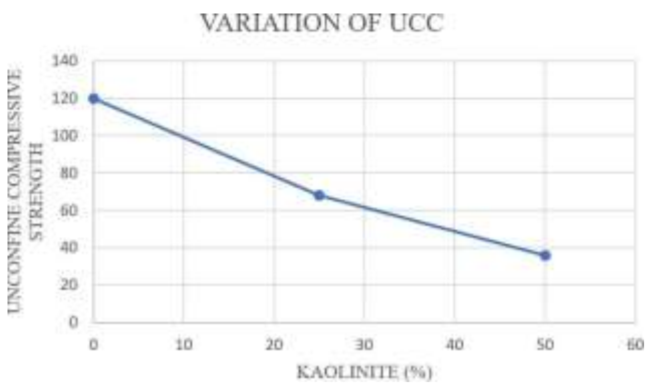

Chart -6: Variation of UCC with kaolinite content

Permeability: it is major property of the soil, which gives an idea about the seepage through the soil. The permeabity is improved up to 25% addition of kaolinite, after that it shows a negative trend.

5. CONCLUSIONS

The sepiolite is mixed with varying percentages of kaolinite and various percentages of fly ash separately. The fly ash is a non- plastic material which is collected from Tuticorin and kaolinite was collected from EICL Veli. The fly ash is mixed with a percentage variation of 0%, 2%, 4% and 6%. The kaolinite is mixed with various proportion of 0%, 25% and 50 % with sepiolite. The physical and engineering properties of mixture is investigated. The variation gives an idea about the property and physical nature of the mixture is checked. The addition of fly ash in the soil shows changes in the properties. The specific gravity and pH of the sepiolite is decreased with increase in the content of fly ash. The soil become more acidic. The soil shows a tendency from changing alkaline to acidic nature. The mechanical compaction test results show a decrease in the optimum moisture content (OMC) and an increase in the maximum dry density (MDD). This results an uplift in the compaction curve from the initial compaction cure towards left. The reduction in the maximum dry density is due to the plastic nature of the fly ash. The consistency index shows decrease in trend. which represents less affinity to water with increase in the fly ash. The unconfined compressive strength of the clay is maximum at 4% of the fly ash content in the sepiolite. There was an increase in the permeability with increase in the fly ash content in the sepiolite.

The addition of kaolinite in the sepiolite shows changes in the properties. The specific gravity of the sepiolite is decreased with increase in the content of kaolinite. The pH of the sepiolite is decreased with increase in the content of kaolinite. The soil become more acidic. The soil shows a tendency from changing alkaline to acidic nature. The mechanical compaction test results show a decrease in the optimum moisture content (OMC) and an increase in the maximum dry density (MDD). This results an uplift in the compaction curve from the initial compaction cure towards left. The reduction in the maximum dry density is due to the plastic nature of the kaolinite. The consistency index shows decrease in trend. which represents less affinity to water with increase in the kaolinite. There was an increase in the permeability with increase in the kaolinite content in the sepiolite.

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