Effect of Lime- Fly Ash In Clayey Soil As Liner

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***Abstract*- Landfills have been used as the most common method for waste disposal throughout the world. Landfill is a carefully designed structure built into or on the top of the ground in which waste is isolated from the surrounding environment. Permeability of liner material is an important factor in construction of landfill. For an effective liner the hydraulic conductivity should be minimum. Fly ash is the waste material formed by the combustion of coal in power plant. Fly ash can used for liner material. This paper studies the effect of lime - fly ash as liner. Varying percentage fly ash is added with six percentage lime. A series of laboratory test is conducted which includes compaction test, Unconfined compressive test, permeability test and consistency test. Sample is cured for seven days. The permeability after first, third and seventh day are determined. Due to addition lime and fly ash the permeability, liquid limit and plasticity index decreases.**

Keywords—Lime, Fly ash, Permeability

I. INTRODUCTION

Landfill liner is a material used to prevent the percolation of leachate in to the underground soil and ground water beneath the landfill. Liner system consists of leachate drainage and collection layer and barrier layer. It should be low permeable, should be robust and durable and should be resistant to chemical attack, puncture and rupture. A liner system consists of combination of barrier material such as natural clays, amended soils, flexible geomembranes and geosynthetic clay liners. Low permeability compacted clays are generally used as seepage barriers in liner and cover systems in engineered landfills. According to Manoj Datta et.al. (1997) the different factors affecting hydraulic conductivity are as follows:-

- Grain size distribution
- Plasticity
- Void ratio and overburden stress
- Degree of saturation
- Compaction and soil structure

Permeability of fly ash in liner application is the property of principal concern. Assuming low permeability controls the flow volumes passing through the liner. If low permeability's are maintained, then the liner will be successful.

Liner requirements and specifications

1. Hydraulic conductivity of 10^{-7} cm or less
2. Thickness of 100 cm or more
3. Absence of shrinkage cracks due to desiccation
4. Absence of clods in the compacted lay layer
5. Adequate strength for stability of liner under compressive loads as well as alongside and slopes
6. Minimal influence of leachate on hydraulic conductivity

II. METHODOLOGY

The soil samples were collected and the laboratory tests were conducted to study the geotechnical properties of collected samples. Compaction and UCC Test were conducted to determine the optimum content of lime in the soil. 0.5%, 1%, 1.5%, 2% and 2.5% fly ash is added with optimum lime content to the soil. The series of permeability tests were conducted before and after curing. Laboratory tests were conducted to check the permeability, consistency limits, unconfined compression strength of various mixes from which a final mix can be selected which is appropriate as a liner.

III. MATERIALS AND PROPERTIES

A. Soil sample

The soil sample is collected from Ernakulam from 8m depth. The index property of the soil is checked in the laboratory and is shown in Table I.

B. Lime

Lime is an unparalleled aid in the modification and stabilization of soil beneath road and similar construction projects. Using lime can substantially increase the stability, impermeability, and load-bearing capacity of the subgrade. Powdered lime purchased from local market.

C. Fly ash

Fly ash, also known as "pulverised fuel ash" , is a coal combustion product that is composed of the particulates(fine particles of fuel) that are driven out of coal-fired boilers together with the flue gases. Ash that falls to the bottom of the boiler is called bottom ash. In modern coal-fired power plants, fly ash is generally captured by electrostatic precipitators or other particle filtration equipment before the flue gases reach the chimneys. Together with bottom ash removed from the bottom of the boiler, it is known as coal ash. Depending upon the source and makeup of the coal being burned, the components of fly ash vary considerably, but all fly ash includes substantial amounts of silicondioxide (SiO_2)(both amorphous and crystalline), alu minium oxide (Al_2O_3) and calcium oxide(CaO).

IV. RESULTS AND DISCUSSION

A. *Determination of optimum content of lime*

1) *Compaction test*

Standard Proctor Test is performed according to IS specification by successive increment of percentage of lime by weight. The lime is added in2%, 4%, 6%, 8%and 10%. Maximum dry density (MDD) was found to be decreased from 1.284 gm/cc to 1.22 gm/cc. Optimum moisture content was found to be varying from 29% to 35%. The addition of lime to clay materials increases their optimum moisture content and decreases their maximum dry density this trend is also reported by bell et al (1996). Result obtained is shown in fig I and fig II.

2) *Unconfined compressive strength*

Unconfined compression test is conducted on the each OMC of the 2%, 4%, 6%, 8% lime content. Strength increase up to the 6% lime and after that it decreases. Thus the optimum dosage is taken as 6%.The UCS value at 6% lime is 1.32 KN/m^2 .Test results obtained are shown in Table II.

B. *Determination of consistency limits*

Consistency test is conducted on the six percentage lime content and varying percentage of fly ash ,ie 0.5%, 1%, 1.5%, 2% and 2.5%.With addition 6% lime and varying percentage of fly ash, liquid limit decrease. The value decreases from 37% to36%.The rate of percentage decrease is 2.7%.Plastic limit increase. The value decrease from 17.83% to 28.29%the percentage decrease is 36.97%.

With addition lime and varying percentage of fly ash Plasticity index decrease. The decrease is from 19.17% to 7.71%.The rate of percentage decrease is 59.7%. Shrinkage limit increase with increase in fly ash content. Result obtained is shown in Table III.

C. *Determination of Unconfined compression strength*

Unconfined compression test is conducted with 6% lime and varying percentage of fly ash .as the lime and fly ash content increase with UCS increase. Result obtained is shown in the Table IV.

D. *Determination of coefficient of permeability*

This is the most important requirement of a liner. For an effective liner the hydraulic conductivity should be minimum. For all the mixes coefficient of permeability was found out before and after curing.

1) *Before curing*

As the fly ash content increase with the 6% lime content, permeability decreases and the results are shown in the Table 5.This due to the cementing materials formed due to the addition lime. Mix with 6% Lime and 2.5% fly ash is lowest permeability value.ie 3.4885E-08 cm/s.

2) *After curing*

With increasing curing time, the permeability decrease is greater Brandl (1981) observed that the permeability decreases with curing time. With increasing curing time, the mineral particles are cemented with the soil-lime-fly ash mixture; the fine skeleton is embedded partly within a gelatinous intermediate mass, hardening products of binder grow into the voids of soil aggregate changing the void structure. Result obtained is shown in TableV .In 3rd curing, the permeability decrease greater than first day.

V. CONCLUSION

The following conclusions are deduced from this study:

- Based on the liner specification all mixes are suitable for liner
- Liquid limit , plasticity index decreases and plastic limit increases with 6% lime and varying percentage of fly ash
- UCS strength increases with increase in lime - fly ash content
- Permeability after and before curing decreases with increase in lime – fly ash content

A FIGURES AND TABLES

TABLE I PROPERTIES OF SOIL

Soil properties	Values obtained
Specific gravity	2.51
Intial water content(%)	55.2
Liquid limit(%)	70
Plastic limit(%)	32.69
Plasticity index(%)	37.31
IS classification	CH
OMC(%)	32.74
Dry density (g/cc)	1.56
Percentage of clay	50
Percentage of silt	38
Percentage of sand	12
UCC strength (KN/m^2)	63.84

TABLE II VARIATION OF UNCONFINED COMPRESSIVE STRENGTH WITH LIME DOSAGE

Lime content	UCS(KN/m^2)
2%	1.185
4%	1.1995
6%	1.32
8%	0.855

TABLE III VARIATION OF CONSISTENCY LIMIT WITH LIME-FLY ASH

	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	SHRINKAGE LIMIT
6%L+0.5%F	37	17.83	19.17	0.862
6%L+1%F	36.6	25.33	11.27	3.831
6%L+1.5%F	36.4	27.54	8.86	4.0275
6%L+2%F	36.2	28.23	7.97	5.747
6%L+2.5%F	36	28.29	7.71	6.849

TABLE IV VARIATION OF UCS WITH LIME- FLY ASH

MIX	UCS(kpa)
6%L+0.5%F	205.964
6%L+1%F	211.89
6%L+1.5%F	232.94
6%L+2%F	254.85
6%L+2.5%F	263.482

TABLE V VARIATION OF PERMEABILITY WITH LIME-FLY ASH

	FIRST DAY	THIRDDAY	SEVENTH DAY
6%l+0.5%f	7.3049E-07	2.49217E-07	2.07854E-07
6%l+1%f	4.72329E-07	1.69018E-07	8.22523E-08
6%l+1.5%f	4.05828E-07	3.67983E-08	3.26923E-08
6%l+2%f	2.32254E-07	3.44984E-08	2.82616E-08
6%l+2.5%f	3.48846E-08	2.03835E-08	1.88213E-08

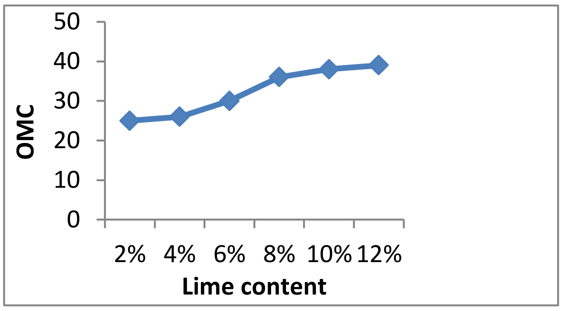

FIG I LIME CONTENT V/S OMC

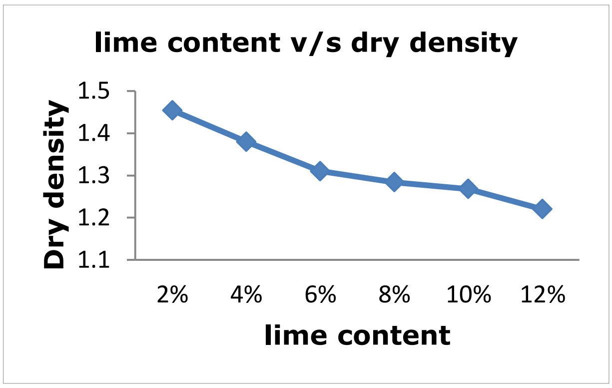

FIG II LIME CONTENT V/S MAXIMUM DRY DENSITY

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