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DIFFUSION CHARACTERISTICS OF KAOLINITE FLYASH LINER

Greeshma B S[1], Rani V[2]

Greeshma B S ,PG Student, Department of Civil Engineering, Marian Engineering College, Tvm

Rani V , Associate Professor, Department of Civil Engineering, Marian Engineering College, Tvm

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Abstract – *Use of sanitary landfills for waste containment is one of the oldest and most popular waste disposal technique.The landfill liner is designed to isolate the waste from the soil beneath to minimize the passage of leachate into the Groundwater . Usually compacted liner materials consist of soil rich in clay minerals for their low hydraulic conductivity. Addition or partial replacement with industrial wastes such as Flyash, Silicafume, Ground Granulated Blast Furnace Slag (GGBS) make the CCL more economical. These industrial wastes are abundantly available, very fine and their use in CCL is an eco-friendly alternative to reduce their environmental pollution. This paper reports the results of short term laboratory tests of diffusion of chlorine ion through Kaolinite partially replaced with flyash. Fly replacement levels are varied up to 30% at regular intervals of 5%. The test results indicated that chlorine ion diffusion is reduced for all replacement levels of fly ash. It is concluded that partial replacement of Kaolinite with fly ash up to 20% is acceptable as diffusion of Chlorine ion increased beyond this replacement level.*

Key Words: kaolinite , Flyash , Liner,Diffusion

1.INTRODUCTION

1.1General

Landfills are the most popular municipal solid waste disposal system The design of liner is made so as to isolate the waste from the environment minimizing the passage of leachate into the groundwater. To ensure this the important characteristics for compacted landfill liners are selection of materials, hydraulic conductivity, strength, compressibility and contaminant retention capacity. Usually soil rich in clay minerals are used as compacted liner materials for their low hydraulic conductivity. . Fly ash is generated in tons as a residue from burning of coal in the power plants .Utilization of this waste material has high environmental value. By compacting the fly ash-clay mixture at the optimum range of dry density and moisture content the bonding between the particles is enhanced which in turn increases the strength and longevity of the liner. The bulk availability of fly ash helps reducing the cost of raw materials required for liner as well as providing their safe disposal in a large scale.

1.2 DIFFUSION

At any temperature different from absolute zero, all atoms, irrespective of their state of aggregation (gaseous,Liquid,or solid) are constantly in motion.Since the movement of particles is associated with collisions , the path of a single particle is a zigzag one.However , an aggregation of diffusing particles has an observable drift from places of higher to places of lower concentration .Due to this diffusion is known as transport phenomenon.

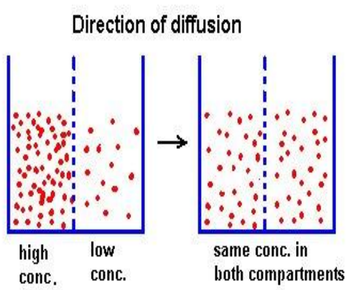

Fig I: Symbolic representation of diffusion (Craig H. Benson et al(1994))

In a diffusion reaction, the flux(matter,heat, electricity…) follow the general relation:

Flux=(conductivity) x (driving force)

In the case of atomic and molecular diffusion, the conductivity is referred to as the fiffusivity or the diffusion constant and is represented by the symbol D. The driving force for many types of diffusion is the existence of a concentration gradient.The diffusion coefficient is calculated using the equation

$$\frac{c2}{c1} = \text{erf}\left[\frac{T}{2\sqrt{D*t}}\right]$$

$\frac{c2}{c1}$ -concentration ratio

D –Diffusion coefficient (m2/s)

T – Thickness of GCL sample

C1-Source tank concentration(mg/l)

C2-Reciever tank concentration(mg/l)

Objective of the study.

- To investigate the basic characterization Kaolinite and flyash
- To study compaction characteristics of kaolinite-flyash liner.
- To evaluate diffusion characteristics of same.

2.MATERIALS AND METHODOLOGY

Materials

Kaolinite : Bentonite for the present study was collected from Associate Chemicals,Kochi

Flyash: Flyash taken from tamil nadu

Table 2:Initial properties of flyash

Properties	Values
Specific gravity	2
Liquid Limit	29
Plastic limit	Non plastic
Plasticity index	Non plastic
Percentage clay(%)	16.25
Percentage silt(%)	29.75
Percentage sand(%)	46
OMC(%)	31.3
Dry density	1.16
UCC(kg/cc)	.94

Properties	Kaolinite
Specific gravity	2.67
Liquid limit (%) (IS 2720 PART 51985)	34
Plastic limit (%) (IS 2720 PART 51985)	23
Plastic index (%) (IS 2720 PART 51985)	11
Shrinkage limit (%) (IS 2720 PART 51985)	21
IS Classification	CL
Natural moisture content (%)	-
Optimum moisture content (%) (IS 2720 PART 7)	24.5
Maximum dry density (g/cc) (IS 2720 PART 7)	1.424
Percentage of clay (IS 2720 PART 4)	66
Percentage of silt (IS 2720 PART 4)	23
Percentage of sand (IS 2720 PART 4)	11
UCC strength (kg/cm^2) (IS 2720 PART 10)	.468

Table I:Initial properties of Kaolinite

Methodology

Compaction test: The test to determine the optimum moisture content and maximum dry density were done using standard proctor test according to IS 2720. 1980 (Part VIII). The variation in optimum moisture content and maximum dry density was studied with the addition of various percentages .

Diffusion test:

Procedure

- Two reservoirs(connected with a pipe) are filled with distilled water
- soil specimen placed in the middle of the pipe
- Allow saturation of specimen for 48hours
- Add any solute of known concentration in one of the reservoir
- Using titration method check the concentration of solute in both reservoirs in different time intervals

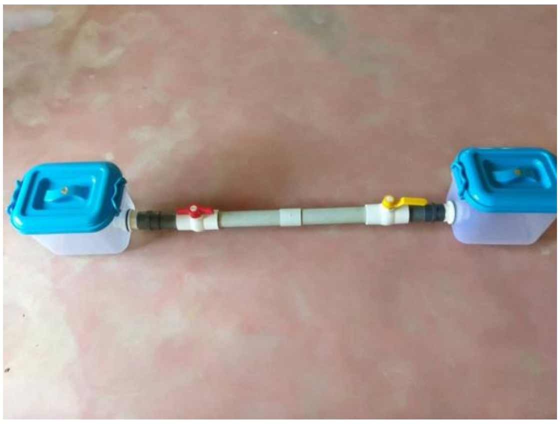

Fig 2: Diffusion mould

RESULTS

compaction results

The value of OMC and MDD obtained from laboratory compaction test provides a reference point while estimating the actual water content of the field-compacted soil liner. If the water content is not in the proper range, the engineering properties of the soil are not likely to be in the range desired. For example, if the soil is too wet, the shear strength of the soil may be too low. Similarly, the dry unit weight of the field-compacted soil may be compared to the maximum dry unit weight determined from a specified laboratory compaction test

Table 4: compaction characteristics of kaolinite flyash mixture

% replacement of flyash	MDD	OMC
kaolinite +0% fly ash	1.424	24.5
kaolinite +10% flyash	1.5	24
kaolinite +15% flyash	1.59	23.6
kaolinite + 20% flyash	1.63	23
kaolinite + 25% flyash	1.6	23.2
kaolinite +30% flyash	1.53	23.6

Diffusion results

% Of Flyash	Diffusion Coefficient Of Cl Ions
0	4.2*10^-10
10	3.9*10^-10
25	2.8*10^-10
30	2.98*10^-10

From these test results it can be understood that partial replacement of clay by fly ash decreases the diffusion coefficient. The reason for this can be attributed to the fact that partial replacement of clay by fly ash makes the clay-fly ash matrix more cohesive as the fly ash particles are finer and act as ball bearing while getting mixed with bentonite. The decrease in Diffusion coefficient of the resulting modified CCL will provide better performance as liner. The replacement of bentonite by fly ash cannot be continued as this replacement increases the permeability of the resulting CCL.

CONCLUSIONS

Based on the laboratory tests conducted the following conclusions are drawn.

1. Partial replacement of bentonite and kaolinite by fly ash decreases the coefficient of diffusion .

2. Partial replacement of kaolinite as well as bentonite by fly ash is an encouraging aspect from the performance point of view of CCL; however, this replacement level shall be restricted to 25%, as permeability of modified CCL increases adversely beyond this replacement level.

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