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Construction, Evaluation and maintenance Of Clay Liners For waste management facilities Without Contamination at ambala (for markand a river)

Anupam Kumar Goit[1], Jitendra Kumar Yadav[2], Sanjesh Chaudhary[3], Er. Kulvinder Singh[4], Er. Deepak Kumar[5], Er. Jatin Thereja[6]

[1,2,3]*Student, Guru nanak institute of Engineering and Technology, Mullana, haryana*
[4]*Asst. Professor & HOD, GNIT, Mullana, haryana.*
[5,6]*Asst. Professor, GNIT, Mullana, haryana.*
Corresponding Author: Anupam Kumar Goit

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ABSTRACT: In 1962, geosynthetic clay liners is developed by Arthur G. Clem. GCLs are also popular as clay blankets, bentonite mats, and prefabricated bentonite clay blankets. Geosynthetic clay liners are factory-prepared minerals sealing mats having hydraulic barriers consisting of layers of sodium bentonite (very low permeability) supported by geotextiles and held together by needling, stitching, or chemical adhesives Geosynthetic clay liners should be used for land coping, sealing pond, to store the water table level and to seal the harmful wastes.

KEYWORDS: Sodium Bentonite, Permeability, Hydraulic conductivity, CBR TEST, Shear strength,

I. INTRODUCTION

Geotechnical engineers and solid waste management agencies have shown more interest in the geosynthetic clay liners to be used as the cover system for the solid and hazardous substances, to preserve the pure water from contaminations. The main function of GCL is to limit the seepage from tailings impoundments and to cover waste disposal landfills.

In landfill applications, GCL is obtain used on materials with low permeability such as clays and silts to reinforced hydraulic barriers. This paper aim to investigate GCL hydration from clay sub soil under daily thermal cycles.

Clay liner(soil liner)

A compacted clay liner is a seepage free barrier constructed of a cohesive soil that is compacted to increase it's bulk dry density and homogeneity. The purpose is to reduce porosity and decrease soil permeability. Within the earthen manure storage structure, the compacted clay liner is designed to impede seepage of the liquid manure.

ADVANTAGES OF GEOSYNTHETIC CLAY LINERS

- It is fast and easy to install and has low permeability and low hydraulic conductivity.
- It can self-repair any holes caused by sodium bentonite.
- It has a very high ability to withstand differential settlements.
- It has excellent freeze-thaw resistance.

II. OBJECTIVE

- The main purpose of this paper is to minimize the wastage of water.
- It serves as a hydraulic barrier to the flow of liquids.
- It minimizes the infiltration of water into buried water(cover system).

MATERIALS USED FOR MAKING GEOSYNTHETIC CLAY LINER

a) Sodium bentonite
b) Geotextile
c) Adhesive

a) Sodium Bentonite

Sodium bentonite is a natural sealant that is used for landfills and for creating artificial water storage. Sodium bentonite expanded when wet, absorbing as much several times as dry masses in water. Because of its excellent colloidal properties, it is often used in drilling mud for oil and gas wells and boreholes for geotechnical and environmental investigations. The property of swelling also makes sodium bentonite useful as a sealant, it provides a self-sealing, low permeability barrier. Its molecular formula is $Al_2H_2Na_2O_{13}Si_4$.

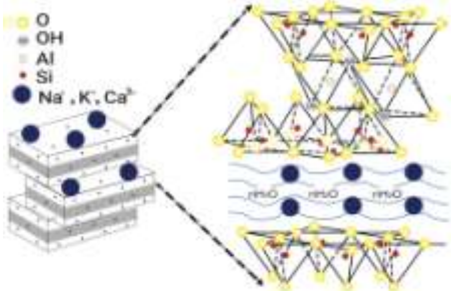

Fig: (1) - Crystalline structure of sodium bentonite with interlamellar water layer.

b) Geotextile

Geotextile is a permeable synthetic textile material that is produced from polyester or main function is to improve the polypropylene polymers. It is used to raise soil stability. its characteristic of soil by filtration or by separation.In clay liners geotextile is used as the replacement for compacted clay liners. It is also used for ground filtration, soil separation, ground reinforcement, soak ways, and land drains.

Fig:(2) – Geotextile

c) Adhesive

Adhesives can be defined as non-metallic materials capable of joining permeability tothe surface by an adhesive process. Polymers adhesive is used in clay liners. A polymer adhesive is a synthetic bonding substance made from polymers and is considered to be stronger, more flexible, and has great impact resistance than other forms of adhesives.

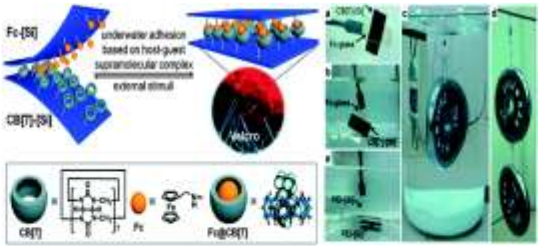

Fig:(3) – Adhesives

III. METHODOLOGY

To determine the properties of clay soil, several tests were carried out such as

- Particle size distribution
- Atterberg limit
- Specific gravity
- Compaction
- Permeability
- Direct shear strength

Table 1 shows the specification of GCL used in this study

Material properties	Test method	Values
Bentonite swell index	ASTM D 5890	24ml/2g.min
Bentonite fluid loss	ASTM D 5891	18 ml max 4kg/ m2
Bentonite mass/sq. area	ASTM D 5993	400 N 65 N
Grab strength	ASTM D 4632	1*10-8wb
Peel strength	4632	5*10 -9 cm/
Index flux	ASTM D	s
Permeability	4632	24 kpa
Hydrated internal shear strength	ASTM D 5887 ASTM D 5887 ASTM D 5321	

Clay soil was compacted at optimum moisture content (OMC) of 14% and maximum dry density of 1870 kg/m^3. Compaction was done using CBR mould having a diameter of 151.5 mm and height of 127.5 mm, the soil was compacted in 3 layers with a hammer height of 300mm and 45 blows per layer to achieve maximum dry density. The soil was cut to the required sizes of100mm*100mm.

Direct shear test was conducted with the maximum horizontal displacement of 15mm and a constant shearing rate of 0.5mm/min. dimension of the upper and lower shear box was 100*100 mm.

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normal stress,100kpa, 200kpa and 300kpa used in this study where to simulate the stresses due to 20m height of land fill based on the assumption that the density of the wet waste was approximately 15kn/m^3.

After the test, shear stress versus displacement was plotted to determine the shear strength at failure for each value of normal stress. The value of shear strength at failure was plotted against the normal stresses to obtain the value of friction angle and adhesion.

Particles size (by weight)

Fines are defined as the soil fraction which passes through a 75µm sieve. clay and sand are defined in the ASTM D2487-00 standard.

1) Percentage fines ≥ 50%
2) Clay content ≥20%
3) Sand content ≤45%.

Fig:(4) – Performing Experiments

Atterberg limits

1) Plasticity index; PI ≥ 20%

Liquid limit; LL≥ 30%

IV. EXPERIMENTAL PROCEDURE

Cyclic heating experiments, the test cells were placed in isothermally isolated box, surrounded with Styrofoam insulation and heated at the top using a heating blanket system to providence-dimensional thermal and moisture migration conditions. To study the effect of thermal cycles on GCL hydration, the temperature controller was programmed to generate temperature cycles similar to those observed for a geomembrane exposed to solar radiation (23–60 °C). The bottom of the cell was kept at a constant room temperature to simulate the thermal gradients that normally develop in the field. For each daily thermal cycle, the test cells were heated for approximately 8 h up to a temperature of 60 °C, and the cells were then allowed to cool for 16 h. The temperatures on top of the GCL and within the subsoil were measured using thermo-couples. A typical cycle of the applied daily thermal boundary condition moisture content of the GCL increased from its initial moisture content until equilibrium in moisture migration between the subsoil and the GCL was achieved. different aspects of the variation in GCL moisture content with time as discussed below. The hydraulic performance of a GCL in a barrier system de-pends, among other parameters, on the degree of saturation of the bentonite in the GCL. The maximum moisture content, to which the GCL is likely to hydrate when immersed in water, was measured at 118% (±5%) for GCL, Thus the degree of saturation of GCL at 80% gravimetric moisture content would be much higher (w/wref= 68%) than that for GCL at the same gravimetric moisture content of 80% (w/wref= 42%). Therefore, both the gravimetric moisture content (w) and the nor-mailed hydration (w/wref) of the GCLs are used.

Direct shear strength

Definition: - The shear strength of a soil is its maximum resistance to shearing stress at failure. The shear strength depends on angle of internal friction(phi) and cohesion(C).

Coloumb has represented the shear strength of soil by the following equation.

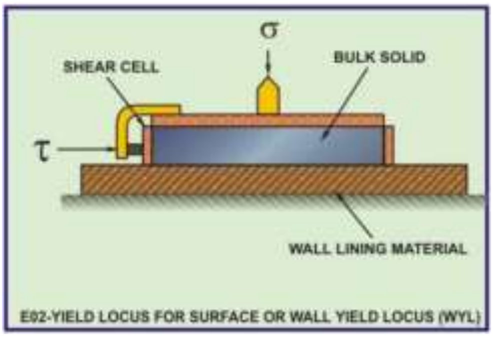
$$s = c + \sigma . \tan \phi$$

ϕ-angle of internal friction

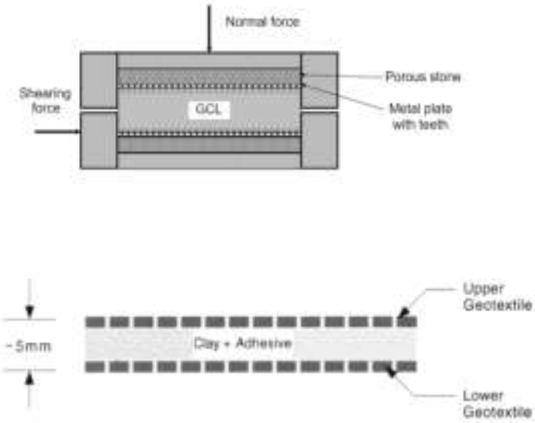
s-shear strength of soil

c-cohesion

σ- total normal stress on the failure plane



Fig(8):- Direct shear test apparatus



Direct Shear Test

Columb has represented the shear strength of soil by the following equation.

$$\tau_f = C + \sigma_n \tan ø$$

V. OBSERVATIONS & CALCULATIONS —

Normal Stress = I Kg/cm^2
Area of Sample = 366m^2

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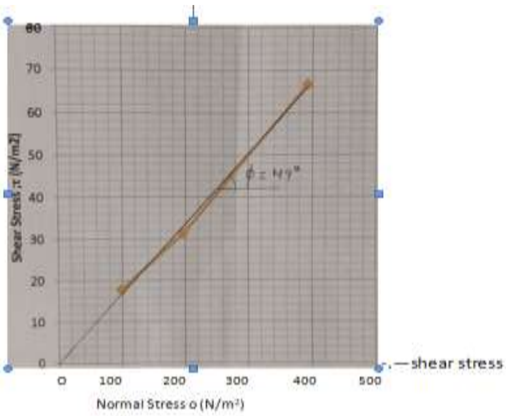
Rate of Loading = 0.25mm/min

Table :For Normal Load- 1 kg/m2

Horizontal Displacement, Mm	Horizontal Load, KN	Effective Area, m^2	Normal Stress, kN/m^2	Shear Stress, KN/m^2
0.340	0.044	$3.6x 10^{-3}$	98.07	12.22
0.620	0.064	$3.6x 10^{-3}$	98.07	17.77

Table : For Normal Load For Normal Load 4 kg/m^2

Horizontal Displacement, Mm	Horizontal Load, KN	Effective Area, m2	Normal Stress, $kÅm^2$	Shear Stress, KN/m^2
0.104	0.0416	$3.6x10^{-3}$	392.28	11.55
0.246	0.0984	$3.6x10^{-3}$	392.28	27.33
0.380	0.152	$3.6x10^{-3}$	392.28	42.22
0.424	0.169	$3.6x10^{-3}$	392.28	46.94
0.510	0.204	$3.6x10^{-3}$	392.28	56.66
0.570	0.228	$3.6x10^{-3}$	392.28	63.33
0.576	0.230	$3.6x10^{-3}$	392.28	63.88
0.600	0.240	$3.6x10^{-3}$	392.28	66.67



Graph : Shear Stress v/s Normal Stress

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SIEVE ANALYSIS RESULTS
EXPERIMENT TABLE
Weight of soil taken for analysis = 1000 g

IS Sieve Size mm)	Particle Size (mm)	Weight of soil retained	Percentage weight retained	Cummulative percentage retained	Percentage Finer (N)
4.75 2.36 1.18 0.600 0.300 o. 100/ 0.075B Pan	4.75 2.36 1.18 0.600 0.300 o. 100 0.075	2.5 1 0.5 5.5 950 33.5 7	0.25 0.1 0.05 0.55 95 3.35 0.7	0.25 0.35 0.4 0.95 95.95 99.3 100	1OO 99.75 99.65 99.6 99.05 4.05 0.7

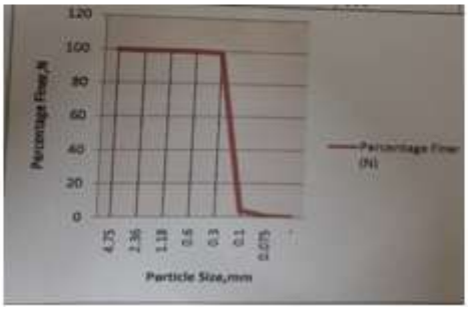

Fig:- GRAPH 1 PARTICLE SIZE v/s PERCENTAGE FINER

Permeability Test It is clear that the scope of a permeability test is to determine the coefficient of permeability (K) of a sample, which is defined as the rate of flow of water under laminar flow condition through a porous medium area of unit cross section under unit hydraulic gradient

Fig:-performing permeability test

Falling head permeability test-

$$K = 2.303\ a.L\ \log_{10}(h1/h2)\ /\ A.t$$

Observations & Calculations -
Length of specimen (L) = 12.5 cm

Diameter of specimen (d) = 10 cm
Area of specimen (A) = 78.53 cm2
Volume of specimen (V) = 981.74 cm3
Area of specimen (a) = 3.14 cm2
Temperature of water (T) = 28 'C.

Table: Falling Head Permeability

S.N0	Initial Head hl (cm)	Final Head h2 (cm)	Time, t (sec)	logło hl/ h2	KT (cm/sec)
1	100	52.5	30	0.279	0.010
2	100	55	30	0.259	0.0099 O.0108
3	100	52	30	0.284	O.0107
4.	100	52.5	30	0.279	

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