Variation in Liquid Limit of Calcium Bentonite Amended with Activated Carbon in GCL

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***Abstract*— Geosynthetic Clay Liners (GCL) are extensively used to replace clay liners in the waste containments. GCL is made by stitching two layers of geotextile with bentonite as hydraulic barrier between the geotextiles. Many researchers have reported on the diffusion characteristics of metal ions through GCL. Addition or partial replacement of Bentonite in GCL, with materials such as Activated carbon, Flyash, Silicafume, Ground Granulated Blast Furnace Slag (GGBS) make the GCL more economical. These materials are abundantly available, very fine and their use in GCL is an eco-friendly alternative to reduce their environmental pollution.**

***Keywords*— GCL, calcium bentonite, activated carbon.**

I. INTRODUCTION

A GCL is a manufactured hydraulic barrier consisting of bentonite sandwiched between two woven geotextiles. The geotextile may be a woven one or a non woven one. Bentonite having low permeability imparts better hydraulic performance to the GCL to act as liner, while the geotextile provides better shear strength to the composite. The geotextile also keeps the fine particles of bentonite intact. Over the past decade GCL's have gained wide-spread popularity as a substitute for compacted clay liners in cover systems and composite bottom liners. They are also used as environmental protection barriers in transportation facilities and storage tanks and as single liners for canals, ponds or surface impoundments. Geosynthetic clay liners are thin manufactured hydraulic barriers comprised of a thin layer of bentonite bonded to layers of geotextiles and/or a geomembrane. Presently International Standards Srganizations (ISO) refer to them as clay geosynthetic barriers. Over the past decade design engineers and environmental engineers have shown great interest in the use of geosynthetic clay liners as an alternative to compacted clay covers or else in some cases bottom lining of waste containment facilities because they often have low hydraulic conductivity and also inexpensive. GCLs are used as environmental protection barriers in transportation facilities (roads and railways) to minimize pollution of subsurface strata from accidental spills and seepage of chemicals or as secondary liners for storage tanks at fuel stations for ground water protection and single liners for canals, ponds or surface impoundments site.

II. EXPERIMENTAL INVESTIGATION

A. Material used

The bentonite used for this study was collected from the Perumbavoor region of the Ernakulam district. It is a low permeable clay with high swelling properties.Bentonite is commonly used in GCL's. The initial properties of the soil was determined by standard test in laboratory. The table 1 shows the initial properties of the bentonite clay

TABLE 1 PROPERTIES OF CALCIUM BENTONITE

Parameters	Value
Initial water content (%)	110
Specific gravity	2.26
Liquid limit (%)	110
Plastic limit (%)	54
Plasticity index	56
Shrinkage limit (%)	55
Sand (%)	6.3
Silt (%)	16.2
Clay (%)	77.5
Optimum moisture content (%)	19.12
Maximum dry density (g/cc)	1.463
Clasification based on plasticity characteristics	CH
UCC (KN/m^2)	91.35

Activated carbon also called activated charcoal, is a form of carbon processed to have small, low volume pores that increase the surface area available for adsorption or chemical reaction. Due to its high degree of microporosity just one gram of activated carbon has a surface area in excess of 1,3000 m^2(14,000 sq ft) as determined by gas adsorption. Two types of activated carbon is used here.powdered activated carbon and granular activated carbon

TABLE 2 PROPERTIES OF GRANULAR ACTIVATED CARBON

Parameters	Value
Specific gravity	1.83
Liquid limit(%)	87
plasticity	Non plastic

TABLE 3 PROPERTIES OF POWDERED ACTIVATED CARBON

Parameters	Value
Specific gravity	.76
Liquid limit(%)	113
plasticity	Non plastic

B. Methodology

Liquid limit was tested according to IS 2720.Cone penotrometer was used to find the liquid limit values. Both powdered and granular activated carbon was amended with calcium bentonite at varying percentages.

III. RESULTS AND DISCUSSIONS

VARIATION IN LIQUID LIMIT OF BENTONITE WITH VARYING PERCENTAGE OF ACTIVATED CARBON

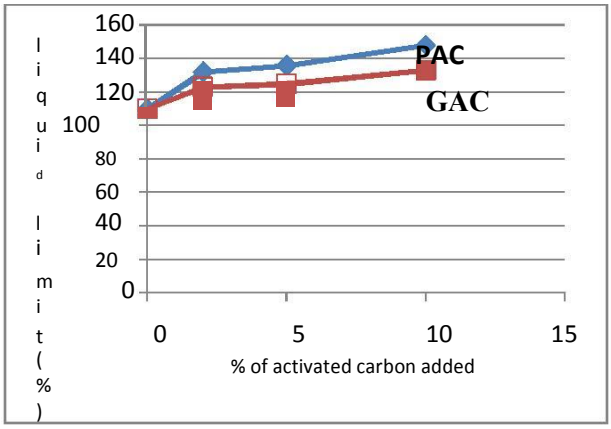

Fig. 2 Variation Of Liquid Limit With Varying Percentages Of AC

VARIATION IN PLASTIC LIMIT OF BENTONITE WITH VARYING PERCENTAGE OF ACTIVATED CARBON

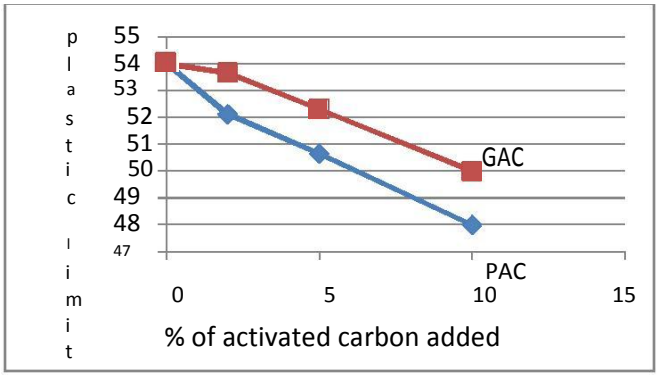

Fig. 3 Variation Of plastic Limit With Varying Percentages Of AC

The graph shows an increasing trend of liquid limit for both PAC and GAC.this can be explained by the high water absorbtion capacity of both PAC and GAC due to the presence of increased amount of micropores in activated carbon.From the analysis of graphs it can be seen that there is a slight increase in the liquid limit value of bentonite amended with PAC than bentonite those added with GAC at varying percentages .This is due to the higher specific surface area of PAC than GAC.The second graph shows a decreasing trend in the plastic limit of both PAC and GAC.

IV CONCLUSION

In this project, an experimental study to obtain the variation in liquid limit of calcium bentonite with amendment of activated carbon was investigated. From the observations the following conclusions were drawn

i. The amendment of activated carbon increases the sorption behaviour of the clay liner.
ii. The liquid limit value of both PAC and GAC increases with increase in carbon content upto 10%
iii. The increase in liquid limit is due to the high micro pores present in the activated carbon
iv. The liquid limit of PAC is greater than that of GAC and is due to the high specific area of PAC when compared to GAC

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