

SOME STUDIES ON CLAYS IN CLAY LINERS AND GEOSYNTHETIC CLAY LINERS

By

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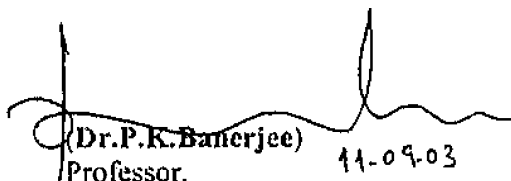
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Dedicated to
my
dear brothers and sisters

CERTIFICATE

This is to certify that the thesis entitled, "Some Studies on Clays in Clay Liners and Geosynthetic Clay Liners " being submitted by Sheela Evangeline.Y to the Indian Institute of Technology, Delhi, for the award of the Degree of Doctor of Philosophy is a bonafide record of research work carried out by her under our supervision and guidance. The thesis work, in our opinion, has reached the requisite standard fulfilling the requirement for the Degree of Doctor of Philosophy.

The results contained in this thesis have not been submitted, in part or full, to any other University or Institute for the award of any degree or diploma.


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ABSTRACT

In India, engineered landfills for municipal waste containment in all megalopolis and for hazardous wastes in all major industrial townships/areas are now mandatory. In view of this, detailed studies are essential on the permeability characteristics with locally available soils in order to assess their suitability in lining systems either as CCLs or as a possible replacement to Na-montmorillonite in GCLs.

In addition, in the commercially available GCLs it has been observed that bentonite is being lost through the geotextile cover during transportation and handling and also in slopes there is a possibility for bentonite to move to lower side whether in dry state or in hydrated state. They also have low shear strength. Thus the present methods of manufacturing GCLs could be improved, keeping the above aspects in view.

Studies have been conducted using commercially available bentonite (Ca-bentonite), black cotton soil and gaggher clay. Also in the laboratory the bentonite was processed to Na-bentonite and studies were conducted on this fourth soil as well.

Apart from the basic physical and chemical characteristics of the soils, the experimental investigation essentially consisted of 1-dimensional confined swell and consolidation and permeability tests in an oedometer with distilled water and different types of fluids as the pore medium. All the laboratory tests were conducted on specimens dry compacted in an oedometer ring to the density normally used in GCLs..

The permeants, apart from distilled water, included, NaOH (0.1M), NaOH (0,01M), HCl (0.1M), Acetic acid (0.15 M) and Synthetic Leachate. A series of tests were

also carried out where in the specimens were first hydrated (saturated with) water and subsequently replaced by Synthetic Leachate and vice versa.

From the laboratory investigation presented in the thesis the following conclusions may be drawn:

1. The index tests like Atterbergs limits and free swell with different leachates are valuable in that they indicate the deleterious effects on sensitive soils like bentonite. However they should be used only for preliminary understanding and not as an alternative to permeability testing.
2. The Na-bentonite produced out of Ca-bentonite appears to have properties similar to Na-montmorillonite commonly used in GCLs. However, permeability is sensitive to the hydrating pore fluid and the applied stress conditions. The difference in permeability could be 2 to 3 orders.
3. Hydraulic conductivity of Ca-bentonite varies from the least value of 9×10^{-9} cm/s when permeated with distilled water to a maximum value of 8×10^{-7} cm/s when permeated with hydrochloric acid. Hence, the same can also be used as a core material in GCLs in addition to Na-bentonite.
4. If bentonite clay is first hydrated with water, and later permeated with a Synthetic Leachate, causes a reduction in k-value and vice versa.
5. When permeated with, liquids other than water, properties of black cotton soil and gagger clay are relatively consistent and hence they can be used as liner material (CCL).

6. A new methodology to prevent the loss of clay powder through the perforations of the cover fabric of GCLs and also to increase the shear strength of GCL has been developed.

Broadly it is seen that the permeability of bentonite and the two other clays studied show that it is in deed sensitive to the perneants, the hydrating conditions and the applied stress. The resulting variations could be 2 to 3 orders.

Thus there is a dire need to obtain the permeability on a case by case basis, by examining the clay liner or GCL with the anticipated permeant.

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