

A Study on Amended Liner Using Kuttanad Clay and Crushed Tile Chips

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ABSTRACT

The design and maintenance of landfills for waste disposal has received great attention over the last few decades due to increasing interest and attention paid to ground water protection. Over the years, the landfill liner construction has developed with the innovation of new practices such as the addition of engineered clays, synthetic lining material and designing of more sophisticated leachate collection systems etc. The main objective of such practices is to enhance the landfill liner performances as a hydraulic barrier and to minimise or prevent the migration of landfill leachate into surrounding hydro-geological system. The greatest threat to ground water posed by modern landfills is leachate. Leachate consists of water and water soluble compounds in the refuse that accumulate as water moves through the landfill. In this study, a clay liner was designed using kuttanad clay,bentonite and crushed tile waste and its geotechnical characteristics were studied to evaluate the capacity of the liner for use in waste landfill. This study investigates the variation of geotechnical properties such as consistency limits, shear strength, permeability and percentage swell of clay liners with leachate. The compatibility of the liner mix was assessed by conducting the jar test with synthetic leachate prepared. The geotechnical characteristics of the liner mix kuttanad clay,bentonite and crushed tile waste as well as the retention characteristics of the liner mix were studied.

Keywords: Hydraulic barrier,hydro-geological,Landfill,Leachate , Retention

I.INTRODUCTION

A municipal solid waste (MSW) landfill unit is a discrete area of land or an excavation that receives household waste and that is not a land application unit, surface impoundment, injection well, or waste pile. An MSW landfill unit may also receive other types of wastes, such as commercial solid waste, nonhazardous sludge, and industrial solid waste. One of the major pollution problems caused by the MSW landfill is leachate, which is generated as a consequence of precipitation, surface run-off and infiltration or intrusion of groundwater percolating through a landfill, biochemical processes and the inherent water content of wastes themselves. Leachate is the liquid residue resulting from the various chemical, physical and biological processes taking place within the landfill. Landfill leachate is generated by excess rainwater percolating through the waste layers in a landfill. The major potential environmental impact of landfill leachate is that it can pollute groundwater, surface waters and soils.

A landfill is a facility which is designed for the safe disposal of solid wastes. The bottom liners and a top cover, of the landfill are considered as the most critical components.

A landfill liner or composite liner is intended to be a low permeable barrier, which is laid down under engineered landfill sites. Until it deteriorates, the liner retards migration of leachate, and its toxic constituents, into underlying aquifers or nearby rivers, causing spoliation of the local water.

II.LITERATURE REVIEW

Landfill liner can be prepared by using locally available soil if it satisfies certain conditions, the most important condition being a low hydraulic conductivity of less than 1×10^{-7} cm/s. Since the determination of plasticity index is too time consuming, the preliminary design can be done such that the resultant mix should have a minimum of 20 to 30% fines and the percentage gravel should not exceed 30%. The maximum particle size is restricted to 25-50mm. the plasticity index should be between 12 and 30%. To form amended clay liners, well graded soil has to be mixed with 5 to 10% bentonite whereas uniformly graded soil has to be mixed with 10 to 15% bentonite. The properties of liner change as it come in contact with leachate. So leachate compatibility of liner should be evaluated before finalizing the liner mix. Studies the mechanisms that influence the contaminant transport are necessary for the evaluation of liners.

III.MATERIALS USED

Kuttanad clay: This paper presents the details and results of an experimental investigation conducted to study the influence of organic content on the physical and engineering properties of the Kuttanad clay.



Kuttanad clay

Dried kuttanad clay

Coir Geotextile

Sodium bentonite: Sodium bentonite expands when wet, absorbing as much as several times its dry mass in water. The property of swelling makes sodium bentonite useful as a sealant, It is used to line the base of landfills.

Coir geotextile: Geotextiles made from coir are durable, absorb water, resist sunlight and are 100% biodegradable.

Crushed tile chip: Crushed tile chips are obtained from construction buildings as a waste .It is used for improving the property of the liner system.

Synthetic leachate solution: A leachate is any liquid that, in the course of passing through matter, extracts soluble or suspended solids, or any other component of the material through which it has passed.A synthetic leachate was prepared by selecting two contaminants which represent a municipal landfill leachate. For the preparation of leachate nitrate and sulphate were selected. The synthetic leachate was prepared by dissolving sodium nitrate and magnesium sulphate in water.

IV.EXPERIMENTAL SETUP

A clay liner was made by mixing kuttanad clay, bentonite and crushed tile chips. The proportion of liner was fixed by trial mixes of 5%,10% and 15% of bentonite added to kuttanad clay.Different tests were conducted to fix the percentage of bentonite.

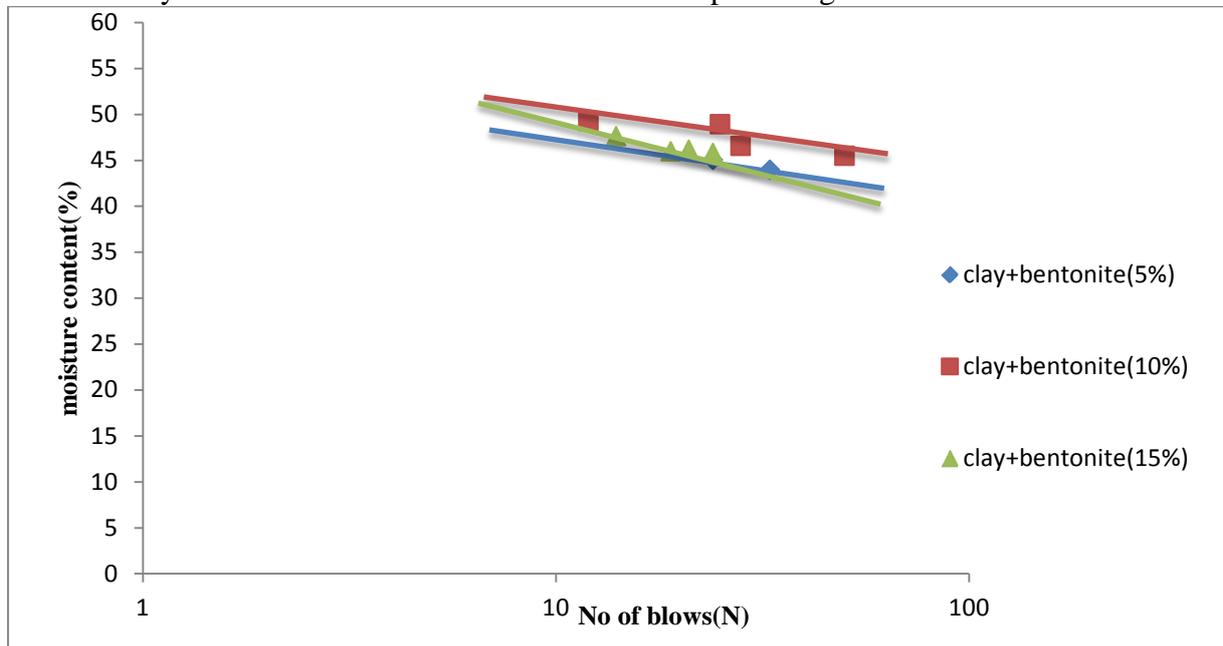


Figure 1:Flow curve for different trial mixes of bentonite

From figure 1 the flow curve for different trial mixes of bentonite are obtained.Kuttanad clay mixed with 10% of bentonite give better result than other trial mixes.Therefore 10% of bentonite can be used for making the liner.

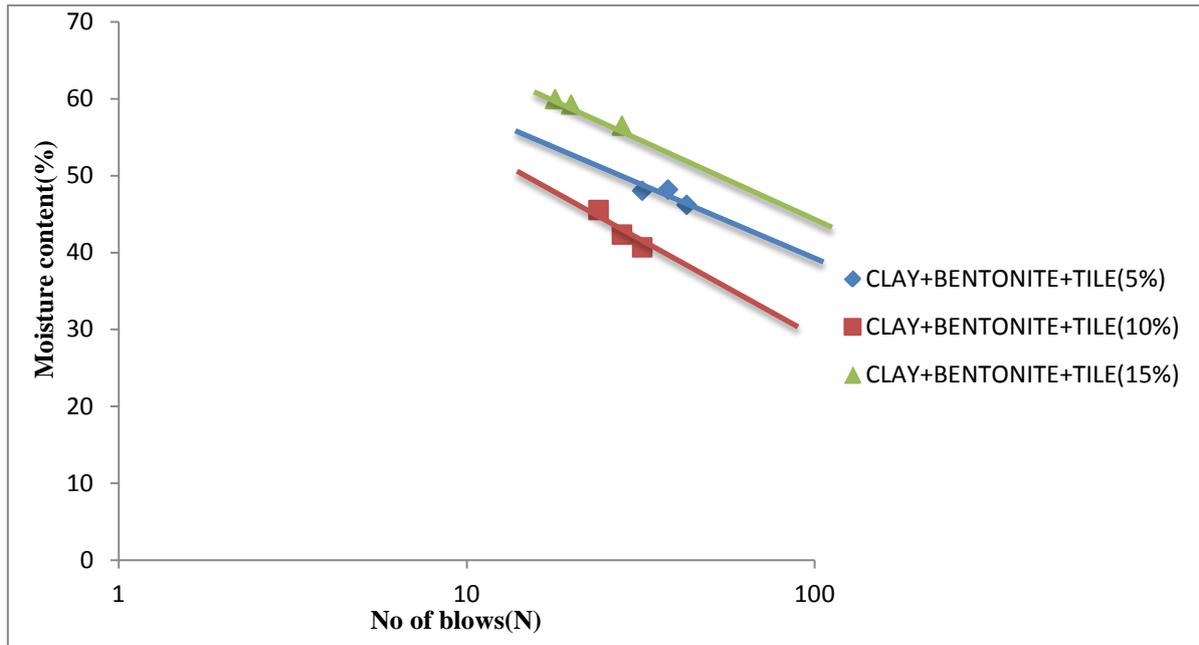


Figure 2:Flow curve for different trial mixes of tile chips

From figure 2 the flow curve for different trial mixes of tile chips are obtained. Kuttanad clay and 10% of bentonite mixed with 15% of tile chips give better result than other trial mixes. Therefore 15% of tile chips can be used for making the liner.

A leachate was prepared by two contaminants which represent a municipal landfill leachate. Sulphate and nitrate were selected as the contaminants. The synthetic leachate was prepared by dissolving salts of magnesium sulphate and sodium nitrate. The quantity of leachate constituents are given in Table 1.

Table 1:Composition of synthetic leachate

Contaminant	Salt used	Chemical formula	Amount added mg/L
Sulphate	Magnesium sulphate	MgSO ₄	320
Nitrate	Sodium nitrate	NaNO ₃	200

The compatibility of the design mix with synthetic leachate was evaluated by permeating prepared leachate through design mix. The experimental setup consists of a three jars placed at different levels. The first jar consist of synthetic leachate solution. The second jar consist of amended liner and the third jar consist of collected leachate after passing through the liner. The required quantity of leachate was added to this soil mass to obtain optimum moisture content. The liner mass was compacted into three layers. The collected leachate needed to be tested.



Figure 3: set up of jars

V.CONCLUSION

This study evaluates the potential usage of clayey soil mixed with bentonite and crushed tile chips as a liner material. The geotechnical properties of liner were studied from different lab tests and jar experiment was done. The reduction in the amount of chemicals after passing through liner was also found out. The following are the conclusions:

1. The geotechnical properties of kuttanad clay is found and it is observed that there is a decrease in liquid limit, plastic limit and plasticity index. The obtained values were 41.5%, 24.31% and 17.19% but the original values of kuttanad clay are 56%, 36% and 20%.

2. By adding different trial mixes of bentonite into kuttanad clay and by adding 10% of bentonite, it was observed that the properties increased and the obtained values of liquid limit, plastic limit and plasticity index are 55%, 35.18%, 19.82%.

3. As a proper method for waste disposal of tile chips, the tile chips were collected, crushed and added into the mix of kuttanad clay and bentonite. Different trial mixes were added and the obtained values of liquid limit, plastic limit, plasticity index and shear strength are 58.1%, 32.5%, 25.6% and $.41 \text{ kg/cm}^2$. They match with the requirements of landfill liner.

4. After allowing the leachate to pass through the liner, the effluent is collected on a bottle and given for testing. It was observed that 320mg/L of sulphate and 200mg/L of nitrate reduced to 150mg/L of sulphate and 100mg/L of nitrate after passing through the liner. So we can conclude that the chemicals are adsorbed by the liner.

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