# Experimental Research on Anti-seepage Performance of Modified Clays

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**Abstract.** In this paper the issues of impervious performance based on fly ash clay are analyzed in detail. The specimen preparation experiment and variable head permeability experiment are introduced. The experimental results of this paper can provide reference for practical engineering application of fly ash-modified clay in the landfill.

## Introduction

With the rapid development of economic construction in our country and accelerating of modern city, living garbage is essentially so-called solid waste, the number of living garbage in cities has increased dramatically, and deal with the problem of living garbage has become one of the current problems to be solved. At present, domestic waste treatment is the main processing method in sanitary landfill method. But this method has certain environmental pollution problems, main displays in the pollution caused by landfill leachate [1]. And this method also has some problems such as: mainly in landfill leachate that may arise during this part of the leachate is due to fermentation, rain erosion, surface water caused by immersion. This paper researches the seepage and performance of landfill liners, the main idea for solve the problem of crack and collapse by adding fly ash to the natural clay to make performance [2, 3]. This article mainly discusses the research problem of based on fly ash to change impermeable and performance of clay liner, focusing on the issue experimental research, by preparing samples of fly ash modified clays and fly ash modified clay experiment variable head permeability test, through the above experiments to determine the permeability of clay modified by fly ash meets the requirements.

## Based on The Modified Clay Sample Preparation Experiment of Fly Ash in Landfills

**The meaning and purpose of experiment.** The important indicators of cohesive soil quality are moisture content and the plastic limit index**.** The crucial water content coefficient is the maximum moisture content of cohesive soil from one state into another state. According to its different cohesive soil moisture content, it can be divided into four states. The limits of moisture content are shrinkage limit, plastic limit and liquid limit respectively. The plastic limit is the index difference of liquid limit and plastic limit. As seepage control material, liquid limit of clay, plastic limit and plastic limit index have a good anti-seepage effect within a certain range, according to the international requirements for seepage control material in landfill, the plastic limit index should be between 10% and 30%. Plastic limit index exceeds this limit will be more sticky, it will be difficult to field operations, while easy to form a lump is hard to break. Saturation has some influence based on the modified clay liner seepage coefficient of fly ash. The more residual gas of porosity in impermeable layer, while the saturation of obtained sample by configuring is low, making the barrier layer effective penetration area will be greatly reduced. The main purpose of this experiment is dry air in the sample, and then to test the modified clay permeability to the fully saturated.

**Experiment materials and equipment.** The main experimental material such as: water, clay and fly ash, the main experimental equipment as follows: compactor, saturation instrument, special compaction cylinder test with a screwdriver, knife ring test, sprinkler, trays, Vaseline and so on.

**Experiment methods.** The experiment divided into the following three experimental procedures, as described below: 1) Formulating in different proportions of fly ash modified clay. By proceeding configuration from experiment conclusion, which is mainly based on geotechnical mechanics performance of the modified clay experiment of fly ash get the proportion, through the experiment, making the moisture content of fly ash modified clay to achieve the optimal. With a good sample, and then storing it in the shadows and putting it in more than 12 hours and in order to make water fully distributed evenly. 2) The modified clay has been equipped with a good sample which is divided into four layers, compaction equipment is adopted to carry out the compaction and 30 times each compaction. 3) Removing the compaction cylinder and flat it on the table, and using the test rings knife for sampling, when leveling is not repeated smear soil samples on both sides to avoid closing the tap, noting at the time of sampling test ring knife on both sides to smooth the soil sample, and marking on each soil sample to use for the back of the experiment.

## Fly Ash Modified Clay to Water Pemeability Test

**The purpose and equipment for experiment.** The quantitative change rule of permeability coefficient of modified clay in garbage landfill and fly ash addition proportion is mainly studied in this experiment. The main experimental equipment is as follows: penetration device of variable water head are shown in Fig.1, the special permeability vessel, the self - made water head device, the sample saturation device and other equipment.

Fig.1. Penetration Device of Variable Water Head

**Experimental procedure and experimental method**. This experiment is mainly through changes in head pressure, in a certain period of time, liquid permeation amount of the seepage of soil samples to determine the permeability coefficient of modified clay [4]. The main calculation formula is as follows: the calculation of the coefficient of variable water head is adopted the following formula.

$$K = \frac{aL}{A(t_2 - t_1)} \times \lg \frac{h_1}{h_2}$$

where K is the permeability coefficient (cm/s), and a is section area of varying head ($cm^2$), where L is to measure altitude of sample (cm), and A is to measure area of sample ($cm^2$), $T_1$ is starting time of the experiment(s), $T_2$ is ending time of the experiment (s), $H_2$ is the starting position of water head in force tube (cm).

Its specific experimental operation is divided into the following 5 steps: 1) putting the modified clay of prepared fly ash samples into saturated container, the loading procedure is required to actual requirements of saturated device. 2) swab off the air in the saturated container to its vacuum state, let water inflow to container when the pressure of saturated container close to the -0.1MPa, stopping swabbing off vacuum when the water level reaches 2/3 of the container. 3) Getting through water inlet of the penetration instrument and water inlet pipe of varying head, 4) exhaust bottom of the air by means of opening vent valve. 5) water injection in the variable head tube closing pipe camp when water level of varying head pipe has a certain height, and at this moment, if there has water overflowing from water outlet, recording the position of beginning water head and time, and recording head position changes according to the predetermined time interval, 5) Repeat these steps for the remaining moisture content as well as samples of different proportions of different compaction measurement sequence.

## Experimental Results and Results Analysis

**The meaning and purpose of experiment**. In this paper, it takes the sample height L=6cm, the sample area A=40cm, the area of the pressure measuring tube is a=3cm$^2$. The results of the experiment are shown in table1-3.

Table1. Impermeable layer permeability coefficient results (Fly ash mixed with 10%)

| Head star $h_1$(m) | Head termination $h_2$(m) | Time (s) | Permeability coefficient at T˚C $10^{-6}$ cm/s | Water temperature T(˚C) | Correction coefficient η | Permeability coefficient K($10^{-5}$cm/s) | The average permeability coefficient ($10^{-5}$cm/s) |
|---|---|---|---|---|---|---|---|
| 69.5 | 33.8 | 79930 | 2.51 | 10 | 1.306 | 3.21 | 3.01 |
| 44.5 | 34.1 | 24520 | 2.50 | 10 | 1.306 | 3.22 | |
| 46.8 | 34.5 | 31200 | 2.42 | 10 | 1.306 | 3.05 | |
| 49.7 | 39.1 | 25300 | 2.31 | 10 | 1.306 | 2.96 | |
| 70.2 | 59.6 | 25100 | 2.11 | 10 | 1.306 | 2.61 | |

Table2. Impermeable layer permeability coefficient results (Fly ash mixed with 20%)

| Head star $h_1$(m) | Head termination $h_2$(m) | Time (s) | Permeability coefficient at T˚C $10^{-6}$ cm/s | Water temperature T(˚C) | Correction coefficient η | Permeability coefficient $K_{20}$ ($10^{-5}$cm/s) | The average permeability coefficient ($10^{-5}$cm/s) |
|---|---|---|---|---|---|---|---|
| 78.1 | 75.9 | 79930 | 0.04 | 10 | 1.306 | 0.05 | 0.044 |
| 77.7 | 75.8 | 25580 | 0.03 | 10 | 1.306 | 0.046 | |
| 75.8 | 74.6 | 58650 | 0.04 | 10 | 1.306 | 0.039 | |
| 76.3 | 75.2 | 61900 | 0.02 | 10 | 1.306 | 0.039 | |
| 75.1 | 74.1 | 28100 | 0.02 | 10 | 1.306 | 0.043 | |

Table3. Impermeable layer permeability coefficient results (Fly ash mixed with 30%)

| Head star $h_1$(m) | Head termination $h_2$(m) | Time (s) | Permeability coefficient at T˚C $10^{-6}$ cm/s | Water temperature T(˚C) | Correction coefficient η | Permeability coefficient $K_{20}$ ($10^{-5}$cm/s) | The average permeability coefficient ($10^{-5}$cm/s) |
|---|---|---|---|---|---|---|---|
| 71.2 | 64.3 | 79930 | 0.35 | 10 | 1.306 | 0.39 | 0.402 |
| 64.3 | 61.9 | 25580 | 0.32 | 10 | 1.306 | 0.42 | |
| 58.2 | 56.1 | 24100 | 0.31 | 10 | 1.306 | 0.38 | |
| 56.3 | 52.6 | 61900 | 0.29 | 10 | 1.306 | 0.44 | |
| 58.2 | 55.9 | 24360 | 0.30 | 10 | 1.306 | 0.38 | |

Impermeable layer permeability coefficient results are shown from Table1 to Table3, respectively. Maximum dry density and optimum water content is an important indicator to measure the effect of impermeable clay soil, which is impermeable and anti-cracking performance to play better. When the clay is added a certain percentage of fly ash, the permeability coefficient is more than in 10-7cm/s, meeting the engineering requirements [5, 6]. The main two reasons are as follows: 1) Due to the permeability coefficient of fly ash is related to the maximum dry density, mixing with a certain proportion of fly ash makes its maximum dry density is reduced and thus the modified clay permeability coefficient decreases. 2) From another point of view, because of the adsorption of fly ash, the adsorption can adsorb metal heavy ion in percolating solution, after the adsorption of heavy metal ions clogging the pores of fly ash particles, its permeability coefficient will decrease. It can be seen that when the content of 20% fly ash is mixed, the permeability coefficient is the smallest. Therefore, in the engineering design and application, we should consider the incorporation of 20% fly ash modified clay as the back lining of impermeable layer, so that permeability coefficient of back lining can effectively prevent the leakage of landfill, and preventing the environmental pollution. Compliance with landfill requirements for impervious material

## Conclusions

This paper is based on the experimental study of the modified clay, 1) analyzing the variation characteristic of permeability coefficient of impervious barrier when mixing variable proportion fly ash into modified clay. 2) The results show that with the proportion is increasing, the numerical value of impervious barrier is decreasing, which is according to the demand of practical engineering.

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