

# Bentonite Blended alluvial Soil for Compacted Clay liner

<sup>1</sup>Indrawati Kumari

Department of Civil Engineering,  
Madan Mohan Malviya University of  
Technology, Gorakhpur, India  
Email: [inkugkp2008@gmail.com](mailto:inkugkp2008@gmail.com)

<sup>2</sup>Dr.S.M Ali Jawaid

Department of Civil Engineering,  
Madan Mohan Malviya University of  
Technology, Gorakhpur, India  
Email: [smaj@rediffmail.com](mailto:smaj@rediffmail.com)

**Abstract:** Compacted soils are mostly used for liner systems of landfills. It is designed based on required permeability and liner thickness. The preferable permeability and thickness are less than  $1 \times 10^{-9}$  cm/s and 0.60 m respectively (EPA 1993). Utilization of locally available soil for liners is an economically convenient alternative (Wijeyesekera et al., 2001). Bentonite has greater influence in altering the geotechnical properties of soil. Keeping this in mind, an attempt was made to blend the local soil with Bentonite in order to achieve permeability in the required range Bentonite blended soil were prepared and compacted mixtures were compacted at optimum moisture content and maximum dry density and its permeability was determined. It was found that 30% is the optimum percentage of Bentonite to be blended with local soil for the construction of landfills liner.

**Keywords:** built compacted clay liner, permeability.

## Introduction:

Solid wastes are inevitable by products of human activities. One of the major challenges all nations face is the disposal of these solid waste in a safe and environmental friendly manner. Due to increase in population, urbanization, industrialization and change in lifestyle. there has been a radical change in the quantity and characteristics of the solid wastes. Hence solid wastes become more hazardous to environment and demands careful disposal practices. The major problem of solid waste disposal is contamination of ground water and pollution of the surrounding environment. The greatest threat to ground water posed by landfills is leachate. Leachate consists of water and water soluble compounds present in the refuse that accumulate as water moves through the landfill. This water may be from rainfall or the waste itself. Leachate may migrate from the landfill and contaminate soil and ground water thus posing the risk to human and environmental health. Hence to safeguard the ground water and surrounding environment from pollutants originating from land filled waste an effective lining and cover system is required.

Modern landfill is highly engineered containment systems designed for the safe and environmental friendly disposal of solid wastes. These facilities basically consist of a bottom liner and a top cover. These components play a vital role in reducing the leachate quantity and the ground water contamination and cover system reduces foul smell and pollution of the surrounding environment.

Hence these are considered as the most critical components of landfill facility. There are different types of liners and covers are in practice However from economic considerations and long term stability against accidental puncture, composite clay liners and covers are most preferred. Composite clay liner is made up of a geomembrane overlying a compacted clay layer having hydraulic conductivity not more than  $1 \times 10^{-9}$  cm/sec.

## Objective: The objectives of this study are as follows:

1. To study the engineering properties of alluvial soil with an aim to construct a liner.
2. To study the effectiveness of using sodium bentonite or improving the permeability characteristics of Local soil.
3. To determine the optimum percentage of bentonite to be mixed with local soil for the construction of compacted soil bentonite liner.

## Materials Used

In this study, the following materials were used:

**SOIL:** Soil sample was obtained from the campus of M.M.M University of Technology Gorakhpur. The engineering property of the soil is given in Table 1 respectively.

**Table no.1: Geotechnical Properties of soil**

S.no.	Properties	Typical value
1.	Specific gravity	2.40
2.	Atterberg limit	Non plastic
3.	Moisture dry density (MDD)	1.77 gm/cc
4.	Optimum moisture contents (OMC) %	14.92%
5.	Permeability cm/sec	$2.4 \times 10^{-5}$

**Table: 2 Geotechnical Properties of Bentonite**

S.no	Parameters	Bentonite
1.	Liquid limit	155
2.	Plastic limit	44
3	Plasticity index	111
4	Optimum moisture contents (OMC)%	26%
5	Maximum dry density (MDD)g/cc	1.43

**Mix Preparation**

Soil has been mixed with Bentonite in different proportion. There after optimum mix has been found on the basis of Optimum Moisture Content and Permeability test and then to the best mix has been selected on the lowest basis of permeability for clay line. The following proportion of mix was prepared as shown in Table 3.

**Table: 3: Geotechnical Properties of Soil mixed with Bentonite**

S. No.	Denoted	Mix preparation
1.	M1	Soil + 3% Bentonite
2.	M2	Soil + 6% Bentonite
3.	M3	Soil +9% Bentonite
4.	M4	Soil +12% Bentonite
5.	M5	Soil +15% Bentonite
6.	M6	Soil +18% Bentonite
7.	M7	Soil +22% Bentonite
8.	M8	Soil +26% Bentonite

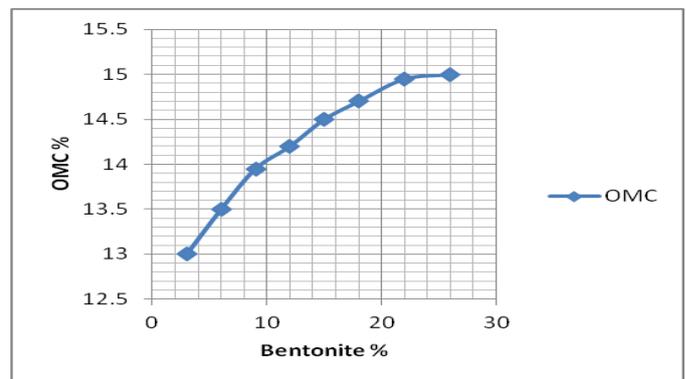
**RESULTS**

The OMC, MDD, and Permeability of various Soil and Bentonite mix are given in Table 4.

**Table no 4: variation of OMC, MDD and PERMEABILITY with Bentonite**

S. no.	Denoted	Determination of omc %	Determination of MDD (g/cc)	Permeability (cm/s)
1.	M1	13%	1.80	$1.8 \times 10^{-6}$
2.	M2	13.50%	1.76	$7.4 \times 10^{-7}$
3.	M3	13.95%	1.71	$3.2 \times 10^{-7}$
4.	M4	14.2%	1.68	$1.5 \times 10^{-7}$
5.	M5	14.5%	1.60	$7.2 \times 10^{-8}$
6.	M6	14.7%	1.54	$3.5 \times 10^{-8}$
7.	M7	14.95%	1.50	$9.2 \times 10^{-9}$
8.	M8	15%	1.44	$1.0 \times 10^{-9}$

The relation between bentonite percentage and OMC as well as MDD as shown in fig 1 & 2 respectively It is evident from Fig 1 & 2 that with addition of bentonite , the optimum moisture content increases and maximum dry density decreases. It is due to fact that since that density of bentonite in less than that the soil, the addition of bentonite leads to the decrease in MDD Abo, because of finess of bentonite surface area of mix increases and hence OMC increases .



**Figure no.1: Percentage of Mix vs. Moisture content %**

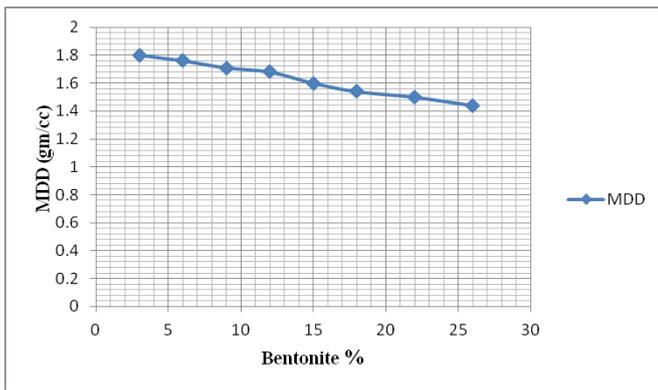


Figure No. 2: Percentage of Mix vs. MDD (g/cc)

The effect of addition of bentonite on the permeability of mix is shown in fig 3. It is found that the hydraulic conductivity of soil bentonite mixtures decreases with increasing bentonite content. Hydraulic conductivity decreased from  $1.8 \times 10^{-6}$  cm/s for the soil without bentonite to  $1.0 \times 10^{-9}$  cm/s for the soil with 26% bentonite. The common regulatory requirement for compacted soil liners states that the hydraulic conductivity should be less than  $1 \times 10^{-9}$  cm/s. For bentonite additions of 26%, the hydraulic conductivity is less than  $1.0 \times 10^{-9}$  cm/s.

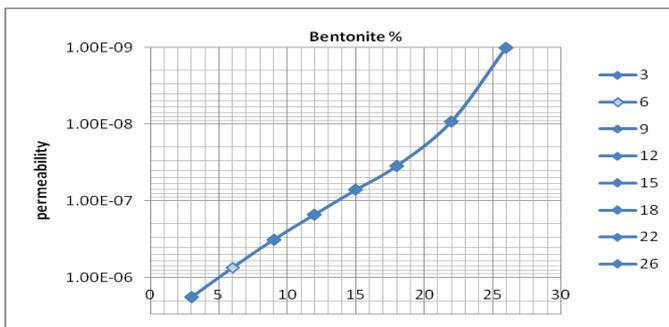


Figure no. 3: Mix % vs. Permeability

**Conclusion**

To develop an optimum bentonite-soil mixture, which satisfies the minimum hydraulic conductivity requirement, is mechanically stable and cost effective an intensive laboratory testing programme was carried out. For laboratory testing, various combinations of bentonite-soil mixtures were prepared in laboratory to assess their engineering parameters. The compaction behavior, hydraulic conductivity of soil bentonite mixtures studied. The following are the main conclusions.

1. It is found that when bentonite content varied from 3 to 26 %, the maximum dry density decreases from 1.80 g/cc to 1.44 g/cc and the corresponding optimum moisture content increases from 13% to 15%.
2. It is found that coefficient of permeability (k) decreases with increase bentonite content. Coefficient of permeability decreased from  $1.8 \times 10^{-6}$  cm/sec to  $1.0 \times 10^{-9}$  cm/sec when bentonite content increased from 3 to 26% and k also decreases with increase bentonite. An optimum 26% bentonite

soil mixture satisfies the minimum requirements of permeability.

3. Thus 26 % of bentonite may be mixed with local alluvial soil for the construction of liner for the landfills in this region

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