Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 03, March-2016

Effect of Bentonite on Hydraulic Conductivity of Landfill Liner

Chinju Vijayan
Assistant Professor
Civil Engineering Department
Royal College of engineering & Technology
Akkikavu, Thrissur, Kerala, India

Hashmi Dev C.
B.Tech Student,
Civil Engineering Department
Royal College of engineering & Technology
Akkikavu, Thrissur, Kerala, India

Roshny Johny
B.Tech Student, Civil Engineering Department
Royal College of engineering & Technology
Akkikavu, Thrissur, Kerala, India

Swathi P.V.
B.Tech Student, Civil Engineering Department
Royal College of engineering & Technology
Akkikavu, Thrissur, Kerala, India

***Abstract*—A large amount of waste is produced by the human activity. Rapid urbanization and social behavior are the major reason for generation of Municipal Solid Waste (MSW). There for there is an urgent necessity of improve planning and implementation of comprehensive MSW management. And its disposal by landfilling is one of the best methods. It is the most efficient and economical method to control the surface dumping of waste. Nowadays landfill becoming less due to the lack of space available and leachate leakage into ground water. Landfilling consists of a liner system at the base and it is the most important part of a landfill as it separates ground water from the leachate. Usually the liner system is made of locally available clayey soil incase if the clayey soil is not present, the locally available soil is mixed with bentonite to form an amended soil liner. The locally available soil collected from Guruvayur is having a permeability of 7.3 x 10^{-4} cm/s, which is higher than the limit. So add various percentages of bentonite such that 2%, 4% etc. to the locally available soil to achieve the permeability limit as per regulation. It is found that with the addition of 7% of bentonite soil is achieved the required permeability of 9.89 x 10^{-8} cm/s.**

***Keywords*—Municipal solid waste, Leachate, amended soil liner, Permeability,**

I. INTRODUCTION

The current global municipal solid waste generation level is approximately 1.3 billion tonnes per year. And are expected to increase by approximately 2.2 billion tonnes per year by 2025. Throw away culture and open dumping cause a lot of land area will be lost. But these wastes are not properly managed. Within this framework, landfills are a best mechanism for effectively treating and disposing of those wastes at the present time. One of the major issue associated with landfilling is contamination of ground water. A low permeability liner is a solution for preventing the leakage of leachate into the ground water. If available soil is of not a low permeability, the hydraulic property is improved by addition of bentonite. This study mainly focuses on the properties of bentonite enhanced soil and also examines suitability as a liner material.

The main property that is to be satisfied by a liner is that his hydraulic conductivity must be less than 1 x 10^{-7} cm/s. laboratory studies have demonstrated that low permeability is easiest to achieve when the soil is compacted to wet off optimum water content. The minimum requirements recommended to achieve a hydraulic conductivity less than or equal to 1 x 10^{-7} cm/s for most soil liner materials are as follows. [2]

The percentage fine must be between 20-30%, plasticity index must be between 12-30 %, percentage gravel must be less than 30% and maximum particle size should be 25-50mm. if suitable materials are un available locally, local soil can be blended with commercial clays example bentonite to achieve low hydraulic conductivity. Relatively small amount of bentonite can reduce hydraulic conductivity as much as several orders of magnitude. [9]

One should be conscious about using highly plastic soils (soils with grater plasticity indices, 30-40%) as it forms hard clods when the soil is dry and are very sticky when the soil is wet.

II. MATERIALS AND PROPERTIES

A. Soil

Soil was collected from Guruvayur. Since the liner is preparing for the landfill site at Guruvayur. Soil passing 4.75 mm sieve was used for this study. The particle size distribution curve of soil passing is shown in Fig.1. Index and engineering properties of soil are found out in the laboratory as per bureau of Indian standard which show in Table I.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 03, March-2016

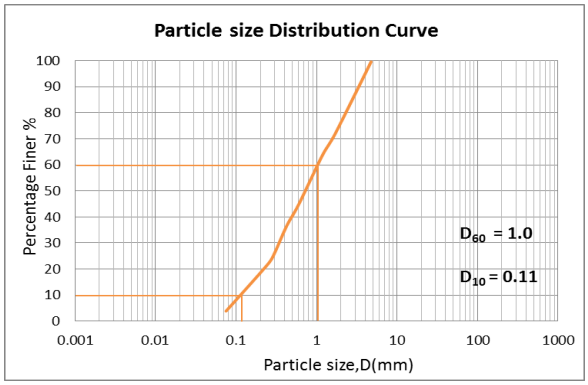

Fig.1 Particle size distribution curve

TABLE I. PROPERTIES OF LOCALLY AVAILABLE SOIL

Properties	Values
Specific gravity	2.67
Liquid lmit (%)	20.3
Plastic limit (%)	13.7
Plasticity Index	6.30
Shrinkage limit(%)	7.81
Maximum dry density	1.921 g/cc
Optimum moisture content	13 %
Permeability	7.3 x 10^{-4} cm/s

B. Bentonite

Bentonite is naturally occurring clay with high expansion capability and low water permeability. Two types of commercially available bentonites are there. Sodium bentonite is used in this study. The engineering and index properties of bentonite were found out in the laboratory as per Indian standards and are present in Table II.

TABLE II. PROPERTIES OF BENTONITE

Properties	Values
Specific gravity	2.60
Liquid limit (%)	350
Plastic limit (%)	52.4
Plasticity Index (%)	297.6

III. EXPERIMENTAL PROGRAM

A. Compaction Test

To determine the amount of compaction and the water content required in the field compaction tests done in the laboratory. Standard proctor test were used to carried out to determine the optimum moisture content and maximum dry density of soil with different percentage of bentonite such as 2%, 4% etc.

B. Permeability test

The permeability of soil and bentonite mix is found out by variable head permeability test. For the test the mixture of soil and bentonite is compacted to wet off optimum.

C. Soil as liner material

Resultant mix of liner should have a minimum of 20 to 30% fines and the percentage gravel should not exceed 30%. And the plasticity index should be between 12 and 30% and maximum particle size is restricted to 25-50mm.

IV. RESULTS AND DISCUSSIONS

A.Effects of bentonite on OMC and dry density of soil

The compaction curves of different mix ratios are shown in Fig.1. It is found that with the increase in percentage of bentonite the dry density decreases and corresponding optimum moisture content increases.

The variation of OMC and maximum dry density with varying bentonite percentages are shown in Fig.2. and Fig. 3. respectively. It is obtained that OMC increased from 12.2 to 14.5% and maximum dry density reduced from 1.974 to 1.87 g/cc when the percentage of bentonite increased from 0 to 8. Variation of dry density and OMC with different percentages of bentonite is given in Table III.

TABLE III. VARIATION OF DRY DENSITY & OMC WITH DIFFERENT PERCENTAGES OF BENTONITE

Percentage of bentonite	Maximum Dry Density (g/cc)	OMC (%)
0	1.974	12.2
2	1.965	12.5
4	1.948	12.8
6	1.929	13.0
7	1.921	13.2
8	1.870	14.5

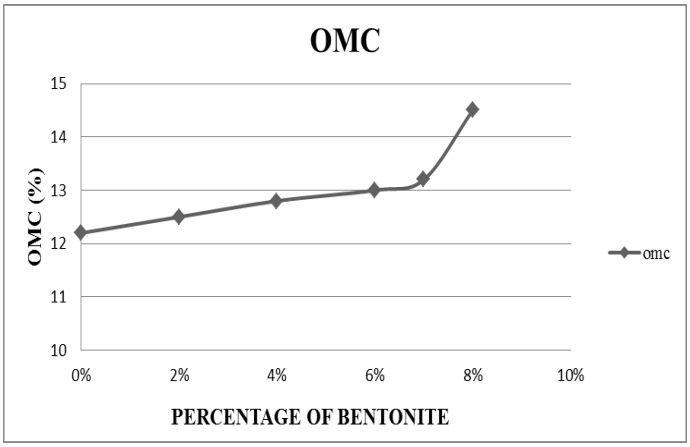

Fig.2. Variation of OMC with different % of Bentonite

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 03, March-2016

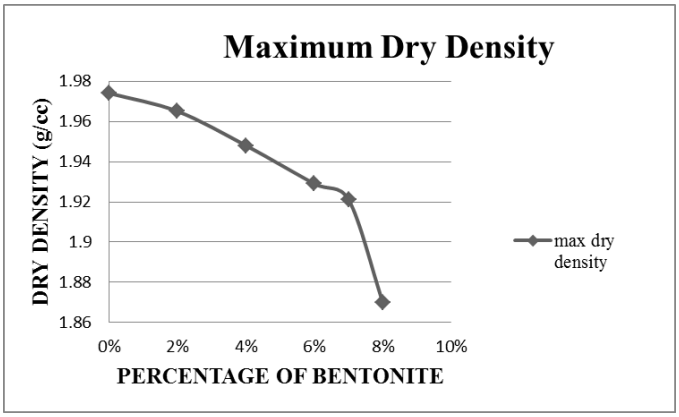

Fig.3. Variation of maximum dry density with different % of Bentonite

B.Effect of bentonite on hydraulic conductivity

Hydraulic conductivity of bentonite enhanced soil compacted to wet off optimum decreased with increasing bentonite content. Hydraulic conductivity of soil at different percentage of bentonite is shown in Table IV. The hydraulic conductivity obtained for 7% bentonite is 9.89 x 10^{-8} cm/s which is less than 1 x 10^{-7} cm/s.

TABLE IV. VARIATION OF HYDRAULIC CONDUCTIVITY

Bentonite content in %	Hydraulic conductivity (cm/s)
0	7.3 x 10^{-4}
2	2.23 x 10^{-6}
4	1.20 x 10^{-6}
6	9.89 x 10^{-7}
7	9.90 x 10^{-8}
8	1.79 x 10^{-6}

C.Check for design of characterisation of liner

The liquid limit and plastic limit of liner mix were obtained das 15% and 25% respectively resulting in a plasticity index of 25%. Since the value is between 12 % and 30 % the mix design can be adopted. The properties of liner are summarized in Table V.

TABLE V. PROPERTIES OF LINER

Property	Value
Liquid limit (%)	15.0
Plastic limit (%)	25.0
Plasticity index (%)	25.0
Percentage fines (%)	26.0
Percentage gravel (%)	8.00
Permeability (cm/s)	9.89 x 10^{-8}
Maximum dry density (g/cc)	1.974
OMC (%)	12.2

V. CONCLUSIONS

These are the conclusions made from the experimental studies.

- When the bentonite content increased from 0 to 8%, the maximum dry density decreased from 1.97 to 1.87 g/cc and optimum moisture content increased from 12.2 to 14.5%.
- With the addition of 7% bentonite the permeability of soil reduced to the range of 9.89 x 10^{-8} cm/s which satisfies the requirement of the permeability of liner.

REFERENCES

[1] Ajitha A.R., and Evangeline Y.S., Sree dhanya, (2010) "Study on amended soil liner using lateritic soil", Indian Geotechnical Conferenence.

[2] Alekhya, M., Divya1, N., Jyothirmai, G., and Reddy, K.R. (2013) "Secured Landfill for Disposal of Municipal Solid Waste." International Journal of Engineering Research and General Science, Vol 1, Issue 1.

[3] Bhagchi, A. (1994). "Design construction and Monitoring of landfill." John wiley and sons

[4] Bhagchi, A. (2004). "Design of landfill and integrated solid waste management." John wiley and sons.

[5] Carey, P., Carty, G., Donlon, B., Donal, H., and Ted, N. (2000). "Landfill Manual and Landfill Design." Environmental protection agency.

[6] "Environmental Guidelines and Solid waste management" (2000), Environment Protection Authority 799 Pacific Highway

[7] Gupta, A. and Rajamani, P. (2015) "Toxicity Assessment of Municipal Solid Waste Landfill Leachate Collected In Different Seasons from Okhala Landfill Site of Delhi." P. J. Biomedical Science and Engineering, vol 8, 357-369.

[8] Paulose, E. and Ajitha, A.R. (2014). "Permeability Studies on Different Prefabricated Landfill Liners Developed Using Coir Geotextile and Polypropylene Felt." International Conference on Innovations & Advances in Science, Engineering and Technology, Vol 3, Issue 5.

[9] Paulose, E. and Evangeline S. (2013). "Effect of Leachate on Amended Soil Liner." International Journal of Engineering Research and General Science, Vol 1, Issue 1.

[10] "Pollution control acts, rules & notification issued thereunder" (2010). Ministry of environment & forest, govt. of India.

[11] Yedhla, S. (2005). "Modified landfill design for sustainable waste management." International Journal of Global Energy Issues, Vol. 23, No. 1.