Impact of Municipal Leachate on Permeability Characteristics for Stratified Soil

[1]Priyanka P, [2]Lokeshappa B
[1]Student, [2]Associate Professor
University B.D.T College of Engineering. Davangere, Karnataka, India.

Abstract— Permeability of permeable media is a significant property which relies on different properties of soil. The main aim of intended work is to assess the characteristics of stratified soil with respect to index and engineering properties after passing the leachate through the stratified bed. The process mainly consists of clayey gravel bed, silty sand bed and stratified soil bed with remoulded soil profile is constructed to correlate the vertical flow to the soil bed. From the present dissertation work it can be concluded that by passing leachate through the soil, the permeability co-efficient increases and reaches maximum of 2.89×10^{-3} cm/sec, 7.32×10^{-3}cm/sec and 4.35×10^{-3} cm/sec at 4 hours for silty sand, clayey gravel and stratified soil respectively, after the permeation point the coefficient of permeability decreases and reaches the maximum level at 24 hours of 2.46×10^{-3} cm/sec, 5.756×10^{-3} cm/sec and 3.26×10^{-3} cm/sec for respective soil beds. The soil properties such as specific gravity, liquid limit, plastic limit, shear strength were found to decrease in contaminated soil when compared to uncontaminated soil. pH and EC increases in contaminated soil when compare to uncontaminated soil.

Index Terms— Permeability coefficient, Stratified soil bed, Contaminated soil, Uncontaminated soil.

I. INTRODUCTION

Municipal solid waste is formed by several solid wastes which are collected from different places in towns and cities of household activities. It includes biodegradable waste, medical waste and less quantity of e-waste in rare cases [1]. Production of waste increases because of rapid population and urbanization. Earths carrying capacity of waste is less but the generation of waste is more of 30% than the capacity in specific site [2]. In the world municipal solid waste is major method of landfill disposal. In the MSW is major method of landfill dumping. A large amount of leachate is formed because presence of high moisture content in garbage. Water is generated from waste itself, also from air and flow from surrounding land into the landfill. A large amount of leachate is formed because presence of high moisture content in garbage.

Geotechnical engineering properties of soil show a major part in the selection of soil for engineering construction. Among important parameters obtained from geotechnical test is permeability coefficient. This coefficient is important because it helps to ascertain soil ability is to allow liquid to flow in it, this property can be influenced by leachate from dumpsite [3]. The main aim of the work is to study the characteristics of leachate in municipal dump site and study the characteristics of stratified soil with respect engineering properties after passing the leachate on soil.

II. MATERIALS AND METHODOLOGY

Study area

The leachate is used for the proposed work is collected from Municipal landfill in Avargolla village located 7km away from the Davanagere City. The site has been in existence from the past 15 years which is about 33 acre. Volume of waste dumped in landfill was 168 T/day. The type of sampling is grab sampling.

Fig 1: Map showing the Location of Leachate Collection

Table 1: Waste Generation in Davanagere City [4]

Sl.no	Sources of generation	Emission rate	Unit	Numbers	TPD
1	Residential	0.21	Kg/capital/day	1,07,876	111.27

2	Commercial shops	1.50	Kg/shop/day	11,649	17.47
3	Conventional hall	0.58	TPD	57	2.69
4	K.R. Market	2000	Kg/material	1	2
5	Hotel waste	13.08	Kg/hotel/day	456	5.97
6	Meat/chicken shop	8.37	Kg/stall/day	203	1.70
7	Floating population (railway station/ bus stand)	1667	Kg/station	3	5
8	Street sweeping and drain silt			3	19.02
9	Hostels	20	Kg/hostel	18	0.36
10	Vegetable shops	5		90	0.45
11	Waste from h0spitals	10	Kg/unit	56	0.56
Total					168.32

Initial Characteristics of Leachate

The collected leachate sample is examined for determining the initial characteristics for the proposed work. All the analytical procedures were conducted as per standard methods. The initial characteristics of collected leachate are tabulated in Table 4.2 is shown below

Table 2: Initial Characteristics of Leachate Sample

Parameter	Sample
pH	9.63
EC (µs/cm)	108120
TDS (ppm)	160000
TS (mg/l)	86
Turbidity (NTU)	168
COD (mg/l)	21866
Colour (Pt-Co)	39000

SOIL

Two types of soil were used in the proposed work, soil samples was collected in and around Davanagere city. Firstly soil is collected from Nayamati village, near Honalli city which is 53km away from Davanagere. Secondly the soil is collected in Davanagere city itself near Vasanth talkies. A soil sample was collected at a depth of 2.5m and 3m. A bulk sample of approximately 50 kg was taken from plastic bags. Soil samples were taken at the laboratory and analyzed for soil properties, According to IS 1498 by grain size distribution curve sample 1 classified as sand soil and sample 2 as gravel by uniformity coefficient. According to IS 1498-1970 soil is further classified sample 1 as slit and sample 2 as clay than sample is classified as silty sand which consists of Gravel= 13%,Sand= 43%,Silt and clay = 44% and clayey gravel which consisits of Gravel= 47%,Sand= 10%,Clay and silt = 43%

MOULD

The mould is made up of plexiglass which is non-reactive with the leachate and soil. The mould is in the dimension of length, breadth of 15cm and depth of 65cm. Mould should be free from any leakages and breakages. These mould is used for the remoulding the soil profile is constructed to correlate the vertical flow to the stratified soil.

METHODOLOGY

Collected soil sample and leachate were analyzed for initial characteristics and thereafter remould soil profile is constructed for three different types such as silty sand soil bed, clayey gravel soil bed and stratified soil bed were prepared. Leachate is made to flow in vertical direction with respect to soil bed by maintain a constant head flow. Hourly variation is noted down for

permeability characteristics. After 24 hours soil is removed from the mould and changes of soil characteristics were analyzed, because when leachate flows in soil made changes in characteristics of soil and it is contaminated, thus the soil parameters were compared with uncontaminated soil.

Fig 2: Photographic View of Stratified Soil Bed

III Results and discussion

Table 3 Characteristics of Soil between Contaminated and Uncontaminated

Parameter	**Silty sand**		**Clayey gravel**	
	Uncontaminated	**Contaminated**	**Uncontaminated**	**Contaminated**
Specific gravity	2.82	2.56	2.70	2.48
Liquid limit	26%	23%	41%	37%
Plastic limit	Non plasticity		28.928%	25.32%
pH	7.30	8.39	6.92	7.33
EC	0.92 dS/m	1.2 dS/m	0.34 dS/m	0.8 dS/m
Shear Strength	C= 0.66 kg/cm^2 $\Phi = 40^0$	C= 0.54kg/cm^2 $\Phi = 31^0$	C=0.8kg/cm^2 $\Phi = 25^0$	C= 0.72kg/cm^2 $\Phi = 22^0$

Specific gravity of soil is decreased in contaminated soil as compare to uncontaminated soil, because leachate contains higher organic matter, soluble salts and the presence of decomposed organic matter tends to lower the specific gravity.

The organic chemicals adsorbed by the soil, thus it decreases thickness of double layer by decreasing extent of water adsorption and caused in lesser liquid limit, some of the organic chemicals have habit of shrink the diffuse double layer that surrounded soil particles thus the liquid limit varies.

For sinking the double layer the presence of organic chemicals in the leachate is liable thus the plasticity of soil is decreases. The dielectric constant of the leachate may be low and these results in a reduced thickness of double layer related to that in water making the clay particles less plastic.

Shear strength of soil was studied by direct shear test. Shear strength of contaminated soil is decreased by way of compare to uncontaminated soil.

At the point when leachate is blended with soil, the oxides and natural issue present in the soil are broken up in leachate and expands the pH estimation of soil.

Conductivity is a proportion of capacity of material to transmit charges. Increments in electrical conductivity might be conceivably because of increments in broke up salts of sodium and magnesium in soil because of utilization of leachate.

PERMEABILITY COEFFICIENT

Property of soil which permits water to percolates through its continuously connected voids is called its permeability. In soil mechanics, coefficient of porousness k communicates level of permeability. Safety of hydraulic structure is directly affected by water flows through soil exerts considerable seepage forces. Higher permeability of soil, higher rate of settlement. Permeability is indirectly depends on shear strength of soil.

$k = \frac{q}{ia}$ Cm/sec

For stratified soil bed the bottom layer silty sand soil bed and top layer the clayey gravel soil were used of length, breadth and depth of 15cm, soil is used which is passed through 4.75mm sieve. Coarse aggregates are made to put, which helps in the leachate to flow easily. The leachate is made to flow in vertical direction of constant head 82cm. The bottom layer is less pervious than top layer.

Table 4 Shows that the results of Hourly Variation of Permeability Coefficient in Soil Bed

Hrs	Permeability coefficient (10^{-3}, Cm/sec)		
	Silty sand	Calyey gravel	Stratified soil
1	1.601	4.997	2.772
2	2.190	5.238	3.39
3	2.805	7.215	4.075
4	2.89	7.32	4.35
5	2.70	6.51	4.20
24	2.466	5.756	3.26

Fig.

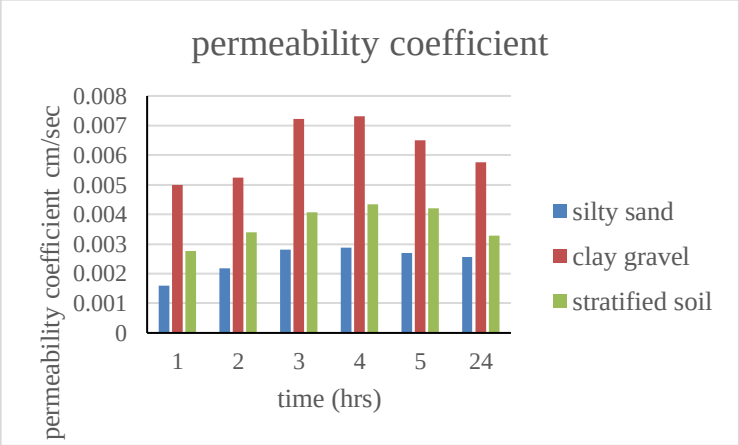

Fig.3 Variations of Permeability Coefficient with respect to Hours in Soil Bed

Property of soil which permits water to percolates through its continuously connected voids is called its permeability. In soil mechanics, coefficient of porousness k communicates level of permeability. Safety of hydraulic structure is directly affected by water flows through soil exerts considerable seepage forces. Higher permeability of soil, higher rate of settlement. Permeability is indirectly depends on shear strength of soil.

Leachate is allowed to pass in the soil beds in the vertical direction by keeping as a constant head. The permeability of coefficient of soil is low at initially 1.601×10^{-3}, 4.997×10^{-3} and 2.772×10^{-3}, its gradually increases as compared to initially 2.89×10^{-3}, 7.32×10^{-3} and 4.35×10^{-3} as the hour goes its starts to decreases in percolation rate as soil starts to clogging as mentioned in the Fig: 4.1, 2.466×10^{-3}, 5.756×10^{-3} and 3.276×10^{-3} in the silty sand soil bed, clay gravel soil bed and stratified soil bed. By comparing both the soil the stratified soil have a moderate percolation rate.

CONCLUSIONS

Two different soil samples were tested for their properties and impact of municipal leachate on soil characteristics were studied and concluded that,

- Leachate increases the permeability coefficient of soil to some extent.
- It is observed that soil was contaminated when leachate flow through soil bed and thus changes in soil properties such as specific gravity, liquid limit, plastic limit, free swelling index are decreases as compare to uncontaminated
- pH, EC are increase in contaminated soil compared to uncontaminated soil.

REFERENCES

1 Niazi N.K., Murtaza B., Bibi I., Sahid M., White J.C., Nawaz M.F., Bashir S., Shakoor M.B., Choppala G., Murtaza G and Wang H (2016). "Removal and Recovery of Metal by Biosorbents and Biochars Derived from Biowastes", *Resource Recovery and Pollution Prevention.* 149-177.

2 Agamuthu P(2011). "Municipal Waste Management". *A Handbook for Management*. 109-125.

3 Oluokun G.O., Agbede O.A., Adeyemi G.A., Akeredolu R.J and Akinniyi B.D (2017). "Impact of Leachate on Permeability Characteristic of Soil Around Lapite Dumpsite in Ibadan, Southwestern Nigeria", *International Journal of Research Engineering and Applied Sciences(IJREAS)*, 7(4)1-10.

4 Shravan B.M and Naagarajappa D.P(2018) "Solid Waste Management in Davanagere", *International Research Journal of Engineering and Technology*, 05(9), 944-940.

5 Javed A., Mohd M., Himans P.S and Priyanka G(2015) " Permeability of Stratified Soils for Flow Normal to Bedding Plane" *International Conference on Water Resources, Coastal and Ocean Engineering.* (4) 660-667.

6 Praveena G.S and Prasasa P.V.V.R (2016) "Impact of Leachate on Soil Properties in the Dumpsite-A Case study of Greater Visakhapatnam", *International Journal of Engineering Research and General Science*. 4(1), 235-241.

7 Milad Z.A (2014). "An Experimental Investigation of Landfill Leachate Impact on Surrounding Soil". *Geoenvironmental Research Centre Cardiff University*. 1-191.

8 Praveena G.S and Prasasa P.V.V.R (2016) "Impact of Leachate on Soil Properties in the Dumpsite-A Case study of Greater Visakhapatnam", *International Journal of Engineering Research and General Science*. 4(1), 235-241.