EFFECT OF COMPACTION AND MOISTURE CONTENT ON GAS TRANSPORT AND WATER RETENTION IN LANDFILL COVER SOIL; MAHARAGAMA LANDFILL AS A CASE STUDY

BY

R.H.K.RANASINGHE

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Supervised by

Dr. UP. NAWAGAMUWA

Dr. K.KAWAMaTO

DEPARTMENT OF CIVIL ENGINEERING

UNIVERSITY OF MORATUWA

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Abstract

In Sri Lanka, Engineered landfills are not being used and only very few controlled landfills are available. The usual procedure is to cover the waste with a good cover soil without providing gas venting facilities. This can be found at Maharagama dumpsite too. Hazardous gaseous and liquid landfill emissions are major problems of landfills. Since gas venting facilities are not provided, pressure inside the waste layer is very high compared to the atmosphere. Hence cover soil of the waste disposal site plays a major role in emission of landfill gases. Once the solid waste is covered with soil these gases are released to the atmosphere with high pressure, through this cover soil. Therefore studying the cover soil parameters are of paramount importance in evaluating and predicting its future gas emission. The Soil gas diffusion coefficient (Dp) and Air Permeability (ka) govern transport and emission of gases to the atmosphere such as of green house gases and volatile organic chemicals in the unsaturated zone. Further, considering gas diffusion coefficient in free air (Do) in this study, soil gas diffusivity (Dp/Do) and air permeability (ka) were measured in the soil which was used as the cover soil of Maharagama waste disposal site. The objectives of the research study were (a) to study about the gas transport parameters of landfill cover soil and (b) to understand effect of compaction and moisture content of the soil on the gas diffusivity (Dp/Do) and air permeability (ka). Measurements were done in 100cm3 repacked soil samples at different compaction levels with the existing moisture contents(normal compacted samples) and soil water matric potentials from pF= 1, 1.5,2,3,4.1 (pF = -log,!" If'matric potential in em H20), air dried and oven dried conditions(pF controlled samples).

In-situ air permeability was measured at the field in order to compare the laboratory and field measurements. At the same time the methane concentration in the research area was measured and a methane concentration contour map was produced.

The air permeability changes from 0 to 100 flm2 while the soil air content varies from 0 to 0.35 m3 m", For the pF controlled samples kavaries from 0 to 100 flm2 and

soil air content varies from 0.02 to 0:35 m3 m-3. In the case of normal compacted sojl sample leavaries from 0 to 80 Jlm2 while the soil air content varies from 0 to 0.28 m3 mo3. The soil gas diffusivity changes from 0 to 0.09 for the pF controlled samples and o to 0.07 for the normal compacted samples. The increase of dry density and reduction of water content increases the amount of soil air content and hence increased the soil gas transport parameters. At the fully dry condition and the with the maximum soil air content and the gas diffusion is around 9% of the gas diffusion coefficient in free air. With dry conditions the changes of soil structure properties also affects the soil gas transport, especially for the soil air permeability. According to the methane concentration contour map the methane concentration is very close to the atmospheric methane concentration all around the ground area except at few hot spots.

Considering the results of this research, Maharagama waste disposal site final cover soil can be expressed as a very less gas exchangeable material. However, it is a very good capping material and the produced landfill gas from the waste layer is trying to migrate through the loosely compacted points around the ground area (high methane concentration was observed in few loosely compacted points). Methane concentration contour map further verifies the experimental results. At the same time, due to low gas exchange through the cover soil, the waste layer will be maintained in an anaerobic condition and hence the green house gas (methane) production is definitely enhanced. In the future, methane emission could be increased through the loose compacted points. These points can become (hotspots) and the formation of the cracks around the ground area would also be possible with time.A long term study is needed to observe the future gas emission at this location.

DECLERATION

I certify that dissertation does not incorporate without acknowledgement of any material previously submitted for a Degree or Diploma in any University and to the best of my knowledge and believe that it does not contain any material previously published or written or orally communicated by other person or except where due reference is made in the text.

R.H.K. Ranasinghe

Admission no:

Certified by

UOM Verified Signature

Dr. U.P. Nawagamuwa.

(supervisor)

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R.H.K.Ranasinghe

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a_s	-	cross sectional area of the soil sample (m^2)
A	-	shape factor (m)
b	-	Campbell pore-size distribution index (-)
C_g	-	soil-gas concentration ($kg\ m^{-3}$, $mg\ l^{-1}$)
C_r	-	relative soil-gas concentration (–)
C_o	-	oxygen concentration in the atmosphere ($mg\ l^{-1}$)
C_i	-	initial concentration in the diffusion chamber ($mg\ l^{-1}$)
D	-	diameter of the soil sample(m)
d_{eq}	-	Equivalent pore diameter(m)
D_p/D_o	-	soil-gas diffusivity (-)
D_p	-	gas diffusion coefficient in soil (m^2 soil air m^{-1} soil sec^{-1})
D_o	-	gas diffusion coefficient in free air (m^2 air sec^{-1})
g	-	gravitational acceleration ($m\ sec^{-2}$)
k_a	-	air permeability (μm^2)
$k_{a,\ in\text{-}situ}$	-	In-situ air permeability(μm^2)
$k_{a,100}$	-	air permeability at soil water matric potential at 100 cm H_2O(μm^2)
Ls	-	length of the sample(m)
Q	-	flow rate of the gas through the soil layer(m^3/s)
X	-	pore connectivity factor(m^3)
ε	-	soil air content.(m^3/m^3)
η	-	dynamic viscosity (g/ cm s)
ΔP	-	pressure difference across the sample
θ	-	soil water content(m^3/m^3)
ψ.	-	soil water potential (m)
Φ.	-	total porosity of the soil(m^3/m^3)
ε_{100}	-	soil air content at soil water matric potential at 100 cm H_2O(m^3/m^3)
τ	-	tortuosity (-)