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Effect of Municipal Solid Waste Leachate on the Quality of Soil

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Abstract: *Dumping of solid wastes on land is a common waste disposal method and practiced almost by all the cities around the globe. Precipitation that infiltrates through the municipal solid waste leach the constituents from the decomposed waste mass and while moving down causes the subsurface soil to be contaminated by organic and inorganic solutes. In the present study an attempt has been made to evaluate the impact of municipal solid waste leachate on the properties of soil at a landfill site at kengeri and BBMP Nayandahalli solid waste disposal site Bengaluru city. Also soil samples were collected from one trial pits, located just around the dump site to serve as control (uncontaminated) soil sample at global village. Soil profile pits were excavated non disposal of solid waste site and solid waste disposal site. Results were compared for the physico-chemical properties of soil. The results show that the values of the natural moisture content of the uncontaminated soil generally lower compared to those of the contaminated soil samples..The chloride concentration in contaminated soil is 108.46 mg/l, it indicates that it is higher than uncontaminated soil which is 40mg/l. This indicates that due to disposal of solid waste the quality of the soil is reduced. Lastly the study conclude based on the results obtained, the disposal solid waste, soil quality is gets reduced compared to uncontaminated soil.*

Keywords: *Dumping of solid wastes on land, Impact of municipal solid wast leachate, Physico-chemical properties of soil, Contaminated soil samples.*

I. Introduction

Accumulated municipal solid wastes in landfills decompose by a combination of physical, chemical, and biological processes [1]. Leachate is generated when water penetrates through the waste in the landfill. The water can be from all forms of water that fall from the air or flow from the surrounding land into the landfill or from the waste itself. Leachates are reflected one of the types of wastewater with the utmost environmental influence. A large volume of leachate is produced in the process of converting solid waste refuse into compost. This is due to the high moisture content of garbage. Garbage leachate has been reported to affect soil physical and chemical properties. It promotes soil aggregation, reduces surface crusting, reduces pH in calcareous soils, and increases soil organic matter [2]. Leachate from municipal solid waste landfills include a variable mixture of solutes, including inorganic ions like Cl-, $SO4_2$-, Ca, Mg, Na and K, heavy metals and volatile/semi-volatile organic compounds. It has been suggested leachate should be used as fertilizers [3]. Making use of any organic matter sources, containing municipal waste leachate (MWL) produced in process of converting solid waste refuses into compost in arid and semi-arid regions is very important. In arid and semi-arid regions, the distinct feature of most cultivated soils is relatively low organic matter (OM) content and, generally, these soils have poor physical characteristics. Consequently, soil application of organic wastes to supply at least a part of the plant nutrient requirement and improve the physical properties of soil is highly important [4]. Besides considerable organic matter content in leachate causing structure improvement and infiltration increase, they include a lot of macro and micro elements such as N, P, K, Fe, Zn, Cu, Mn and Mo that effects on soil fertility and also they involve infrequent elements causing environmental pollution so waste usage needs to be assessed [5].

The decline of soil organic matter (SOM), as a consequence of the application of intense soil cultivation practices, has been identified as one of the most important threats to soil quality .Depletion of SOM, is accompanied by a cascade of adverse impacts, including decreases in soil fertility and productivity, decreased biodiversity, lower microbial activity, instability of aggregates, and reduction in infiltration rate followed by increased runoff and erosion, which further stimulate soil degradation [3].

While the developed countries of the world, such as Germany, have in place effective systems for MSW management [6], in many developing countries, such as Nigeria, management of MSW is a major concern, even in major cities of the country. The increasing level of solid waste is a serious problem in the urban areas of the world. This is compounded by the high rate of population growth and increasing per-capita income, which results in the generation of enormous solid waste posing serious threats to quality of soil and water. These

threats are even more in the developing countries where large quantities of solid waste are dumped haphazardly, thereby, putting pressure on scarce land and water resources and at the same time affecting the properties of soils [7]

While many researchers have worked on the characterization and management of MSW [7] and their effect on groundwater, little attention has been given to the effect of these wastes on the geotechnical properties of soils. This has become even more necessary as the demand for space for residential buildings to meet up with the country's rapidly increasing population, has resulted in the utilization of former dump sites within cities centers for building purposes. Therefore, the need to assess how the geotechnical (engineering) properties of soils on these dumpsites are affected by wastes cannot be over emphasized

The main objectives present paper to evaluate the impact of municipal solid waste on the properties of soil at a landfill site at kengeri, and BBMP Nayandahalli solid waste disposal site Bengaluru city. Soil profile pits were excavated non disposal of solid waste site and solid waste disposal site. Soil physico- chemical properties and Soil geotechnical properties was estimated. Results were compared for the physico-chemical properties of soil with each other i.e non disposal of solid waste site and solid waste disposal site.

II. Materials And Methodology

2.1 Methods of sample collection

In the present paper an attempt has been made to evaluate the impact of municipal solid waste on the properties of soil at locations at kengeri, and BBMP Nayandahalli solid waste disposal Bengaluru city. And these location of contaminated and uncontaminated **soil sites** presented in Table 3.1. Soil profile pits were excavated in non-disposal of solid waste site and solid waste disposal site. Results were compared for the physical, physico-chemical properties of soil with each other.

Samples were collected using Core cutter in both contaminated as well as uncontaminated sites and these samples carefully transfer to plastic bags and then these samples were transported to S.J.BInstitute of Technology Bengaluru for geotechnical laboratory and to analyse. The soil samples were collected from one trial pits, located just around the dump site to serve as control (uncontaminated) soil sample at global village. In order for the control trial pits to be relatively free from the leachate of the decomposing MSW, this was carefully located.

Table. 2.1: Location of contaminated and uncontaminated soil sites.

SL No.	Type of Soil	Location
1	Contaminated soil	BBMP kengeri solid waste disposal site, Bengaluru
2	Contaminated soil	BBMP Nayandahlli solid waste disposal site, Bengaluru
3	Uncontaminated soil	Global Village ground, Bengaluru

2.2 Laboratory Determinations

Dumpsite leachate contains different hazardous substances, some of which threaten the environment. In this paper , dumpsite top soil from different sites were collected and analysed. The selected parameters analysed in the contaminated and uncontaminated soil were pH, solids, alkalinity, chloride, and Subsequently, the various parameters concerning towards the characteristics of soil quality parameters are Natural moisture content, Specific gravity, Particle size distribution, Coefficient of Permeability, Shear strength, Compressibility.

III. Results And Discussion

Experimental results obtained on effect of municipal solid waste lechate on the characteristics of soil on both contaminated and uncontaminated soil presented in Table 3.1. The present paper mainly focussed on identification of selected pollutants in the soil due to lechate generated from municipal solid waste landfill site and uncontaminated soil to serve as control. Finally comparison of both contaminated and uncontaminated soil characteristics was made.

Table 3.1: Quality of soil Parameters estimated in contaminated and uncontaminated soils

Sl No.	Parameters	Contaminated Soil	Uncontaminated Soil
1	Moisture Content	13.98%	11.20%
2	Specific Gravity	2.537	2.430
3	Particle Size Distribution	Cu= 5.5	Cu= 8.57
		Cc= 2.36	Cc= 3.07
		K= 4	K= 1.96
4	Permeability	0.62 Cm/S	0.069 Cm/S
5	Shear Strength	13.5 Kn/Sq M	13 Kn/ Sq M
6	Compressibility	0.82 Sqm/ Kn	1 Sqm/ Kn
7	PH	7.45	8.00
8	Chloride	108.46 Mg/L	40mg/L
9	Alkalinity	83 Mg/L As $Caco_3$	236 Mg/L As $Caco_3$

3.1 Natural Moisture Content of contaminated and uncontaminated soil

The results show that the values of the Natural Moisture Content of the Uncontaminated soil is lower compared to those of the contaminated soil samples. This trend could attribute reason that the contaminated soil is expected to be damper, since the natural ground level is covered by the MSW, thereby preventing direct evaporation of moisture from the soil below.

3.2 Specific gravity of contaminated and uncontaminated soil

The results show that, the values of the specific gravity of the contaminated soil was higher than the uncontaminated soil. It could be attributed that the specific gravity of contaminated soil is higher because of the higher moisture content of the contaminated soil as compared to uncontaminated soil.

3.3 Particle Size Distribution of contaminated and uncontaminated soil

From the Table 3.1 the uncontaminated soil is relatively homogeneous and contaminated soil has more fines than the uncontaminated soil. The higher percentage of fine content recorded for the contaminated soil can be attributed to the fines emanating from the decomposed MSW above the soil. Also during bacterial degradation or decomposition of MSW large amount of fines are produced.

3.4 Permeability Test of contaminated and uncontaminated soil

Laboratory falling head method was used in the determination of the coefficient of permeability of the soils. From the results, the contaminated soil has higher values of coefficient of permeability than the uncontaminated soils. These results somehow contradict the fact that the contaminated soil particles are loosely arranged which would have ordinarily increased the pore space in the soil. This anomaly may be due to particles flocculation as a result of contamination with MSW. The flocculation process may have altered the behaviours of the fine particles from clay-like to silt-like and consequently, making the soil more permeable.

3.5 Shear Strength Test Contaminated and Uncontaminated Soil

The shear strength parameters were determined by undrained triaxial test using undisturbed soil samples. From the results, the shear strength value is higher in case of contaminated soil than those recorded for the uncontaminated soil. The relatively high value recorded for contaminated soil samples a result of pseudo-cohesion, brought about by leachate from the decomposing MSW. This may be due to particle flocculation as a result of contamination with MSW.

3.6 Compressibility Test of contaminated and uncontaminated soil

Consolidation test on the undisturbed samples was use to investigate the effect of the MSW on the compressibility characteristics of the soils. The results show that the contaminated soil has relatively lower values than uncontaminated soil. The lower values obtained for contaminated soil in comparison with the values obtained for uncontaminated soil, can be attributed to the soil immediately beneath the MSW don't undergoing any compression as a result of the weight of the MSW above.

3.7 pH of contaminated and uncontaminated soil

We can conclude that, pH value of uncontaminated soils is higher than the contaminated soils. The pH of the contaminated soils is 7.45, it signifies that it is slightly acidic in nature compared to uncontaminated soil could be reason behind that the nature of the solid waste contribute acidity of the soil. Due to this reason the pH of contaminated soil is slightly acidic than uncontaminated soils. Alkalinity value of uncontaminated soils is higher than the contaminated soils. This could be the reason that the pH of the contaminated soil is slightly acidic than uncontaminated soil.

3.8 Chloride of contaminated and uncontaminated soil

The chloride concentration in contaminated soil is 108.46 mg/l where as uncontaminated is 40 mg/l, it indicates that it is higher than uncontaminated soil. This contribute due to disposal of solid waste, the quality of the soil is reduced and it clearly indicated by the chloride values of contaminated soils.

3.9 Comparison of quality of contaminated soil and uncontaminated soils

The results of contaminated and uncontaminated soils are represented in Table 3.1. The result in the table indicates that except for pH and alkalinity, all other parameters are higher in contaminated soil compared to uncontaminated soils. The study concludes based on the results obtained, the disposal site soil quality is reduced compared to uncontaminated soil. In other words, due to the disposal of solid waste on land the soil quality gets reduced.

IV. Conclusions

Based on the experiment results obtained from the soil sample analysed in both contaminated and uncontaminated soils following major conclusions have been drawn. The coefficient of permeability of the contaminated soil has higher than the uncontaminated soils. These results somehow contradict the fact that the contaminated soil has less fine soil particles are loosely arranged. The relatively high value recorded for contaminated soil samples a result of pseudo-cohesion, brought about by leach ate from the decomposing MSW. This may be due to particle flocculation as a result of contamination with MSW.

The study concludes that the pH value of contaminated soils is lower than the uncontaminated soils and the alkalinity value of uncontaminated soils is higher than the contaminated soils. This could be the reason that the pH of the contaminated soil is slightly acidic than uncontaminated soil.

The chloride concentration in contaminated soil is 108.46 mg/l, it indicates that it is higher than uncontaminated soil which is 40mg/l. This indicates that due to disposal of solid waste the quality of the soil is reduced and it clearly indicated by the chloride values of contaminated soils. Study conclude based on the results obtained, the disposal site soil quality is reduced compared to uncontaminated soil. In other words, due to the disposal of solid waste on land the soil quality gets reduced.

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