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EVALUATION OF THE IMPACT OF MUNICIPAL SOLID WASTE ON SOIL PROPERTIES IN KANNAHALLI, KARNATAKA

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Abstract - *Disposal of municipal solid waste (MSW) in the cities has become a complex problem worldwide. Improper disposal of solid waste is a big problem in Indian cities. Segregation of waste is not at all practiced in our country. Bengaluru generates around 5000 tonnes of MSW per month. In the present study, an attempt has been made to understand the effect of MSW on the soil characteristics of Kannahalli, an urban area in the Bengaluru northern part which is about 19.5km away from city center. MSW is being dumped in this site since a year. Soil samples were collected by excavation at two different locations in the site viz., one right below the landfill and the other about 90ft away from the landfill site. The soil samples collected from sites were tested for change in pH, chloride percentage, alkalinity, BOD and COD. Samples were also tested for geotechnical properties such as liquid limit, compaction characteristics, permeability, UCS and shear strength. Analysis results show that there is an effect on both chemical and geotechnical properties of soil because of contamination of soil*.

Key Words: **MSW, Kannahalli, Chemical analysis, Geotechnical properties, Contamination**

1. INTRODUCTION

Managing Municipal Solid waste is a difficult problem in almost all nations of the world. As the population is rapidly increasing, radius of cities and towns growing at a faster pace, there is also a huge increase of solid waste quantity being generated and hence the solid waste management should be given due importance. Wastes contain various kinds of inorganic and organic contents which may directly and indirectly cause harm to the environment.

Implementation of wastes segregation methods in our country is very rare. Unscientific disposal of wastes is one of the major problems in our nation because of which there are many issues such as public ill health caused by various disease causing microbes present in the landfill site, ground water contamination, soil pollution, effect on flaura and fauna, pollution of water sources, etc. Currently, Bangalore wastes are being dumped at Kannahalli landfill site. Kannahalli is located in Bangalore North of Bangalore district, Karnataka. Kannahalli is about 16 km from district headquarter. The area of landfill site is 25 acres. The quantity of waste dumped at land fill site is about 500TPD.

2. LITERATURE REVIEW

Krishna R Reddy et al. (2008) [9]: Fresh municipal solid waste samples obtained from Orchid hills dumpsite (David junction, Illinois, USA). Land filled municipal waste samples, underwent the process of leachate recirculation under NMC and higher water content for compressibility and shear strength parameters. Compression ratio values for land filled MSW were 0.19-0.24 and 0.24-0.33 for fresh MSW. Direct shear tests results indicated that drained cohesion(c) and drained ϕ value varied from 12-64kPa and 31-35° respectively, for fresh MSW it was 31-64kPa and 26°-30°. Triaxial CU tests conducted on land filled MSW showed that c and ϕ were found to be 39kPa and 12° and that of effective stress were 34kPa and 23°. For fresh MSW c and ϕ were 32kPa and 12° and c' and ϕ' were 38kPa and 16°.

Krishna R Reddy et al. (2011) [11]: Synthetic MSW was prepared and effect of degradation on geotechnical properties was observed. Leachate (with pH 7.5) from orchard hills landfill was added. K value varied from $1.X10^{-5}$ – $8.3X10^{-9}$cm/s. Compression ratio decreased for degraded waste. Drained cohesion varied from 1-40kPa and drained ϕ value varied from 35°-28°. Triaxial CU test results showed that cohesion ranged from 21-57kPa and friction angle ranged from 1°-9°. c' was found to be 18-56kPa and ϕ' ranged from 1°-11°.

Musa alhassan (2012) [13]: The dumpsite under study was located in Jikpa area of Bosso, Nigeria. Soil samples were collected from 3 trial pits, one inside the dumpsite and the other 2 in surrounding areas. They were tested for geotechnical properties in laboratory. Results showed that contaminated soil had lower specific gravity, lower MDD and higher OMC. Cohesion and angle of internal friction was lower for contaminated soil. Contaminated soil had higher NMC, co-efficient of permeability, co-efficient of volume change and co-efficient of consolidation.

Naveen B P et al. (2014) [14]: Investigated the effect of MSW on engineering properties of soil at Mavallipura site. It was observed that permeability, OMC was very high and MDD was low. Direct shear test results showed that c and ϕ values were found to be 10kPa and 26°.

Rakesh kumar pandey et al. (2015) [17]: Collected soil sample near Satna and examined the physical characterization and geotechnical properties of solid waste. It was found that MDD and OMC was very high, permeability

decreased as confining pressure increased. From direct shear test, c and ϕ was obtained as 12 kPa and 38°.

3. OBJECTIVES

The main objective of the study was to compare chemical and geotechnical properties of soil collected at two locations in landfill site.

4. MATERIALS AND METHODOLOGY

4.1 MATERIALS

Excavation was done at two different locations in the landfill site for the collection of soil samples. One sample was collected by excavating right below the landfill. The other soil sample was collected from about 90 ft from the landfill. The samples that were collected from site were disturbed soil samples. The samples were collected in separate polythene bags which were then labeled and transported to the geotechnical laboratory for testing.

Following chemical tests were conducted:

1. pH value determination
2. BOD test
3. COD test
4. Chloride content determination
5. Alkalinity test

Following geotechnical tests were conducted:

1. Determination of specific gravity
2. Grain size analysis
3. Determination of liquid limit and plastic limit
4. Compaction test
5. Unconfined Compression Strength Test
6. Permeability test

4.2 METHODOLOGY

Specific Gravity test was carried out using Pycnometer method. The value of specific gravity is used in various calculations. Liquid limit test was carried out using Casagrande apparatus.

Standard compaction test was conducted according to IS standards for the determination of optimum moisture content and maximum dry density.

Direct shear test and unconfined compression strength tests were carried out according to IS standards.

Chemical tests were conducted according to IS standards.

Comparative study of chemical and geotechnical test results were made.

5. RESULTS AND DISCUSSIONS

5.1 Chemical test reports:

Contaminated Soil:

Table-1: Contaminated soil chemical test report

Sl. No	Parameters	Results	Test method
	Description	Pale brown colored moist soil	Textbook of soil chemical analysis
1	pH (20% suspension)	7.00 at 23.7 °C	
2	Chlorides , as Cl ,%	0.004	
3	Alkalinity , as CacO3 , ppm	18.9	IS: 3025 (part 23)
4	Bio chemical Oxygen Demand (at 27 °C for 3 days)	7.8	IS: 3025 (part 44)
5	Chemical Oxygen Demand	56.6	APHA

Uncontaminated Soil:

Table-2: Uncontaminated soil chemical test report

Sl. No	Parameters	Results	Test method
	Description	Pale brown colored moist soil	Textbook of soil chemical analysis
1	pH (20% suspension)	6.98 at 23.7 °C	
2	Chlorides , as Cl ,%	0.026	
3	Alkalinity , as CacO3 , ppm	14.2	IS: 3025 (part 23)
4	Bio chemical Oxygen Demand (at 27 °C for 3 days)	7.2	IS: 3025 (part 44)
5	Chemical Oxygen Demand	52.5	APHA

Test results showed that there is not much variations in pH. Alkalinity, BOD and COD of uncontaminated soil is less than that of contaminated soil. Chloride content of uncontaminated soil is found to be greater than contaminated soil.

5.2 Grain size analysis:

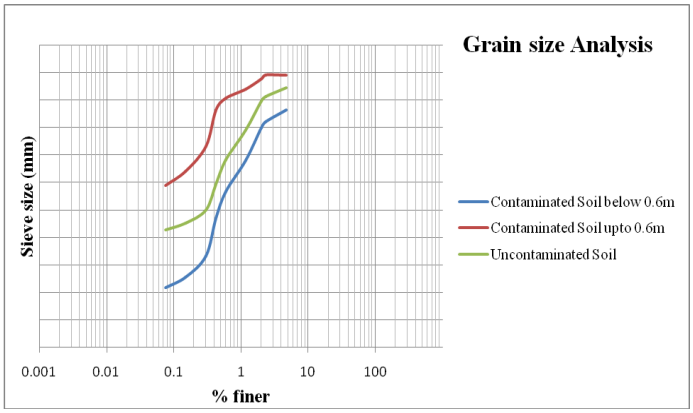

Fig.1.Grain size distribution curve

4.3 Liquid Limit of uncontaminated and contaminated soil:

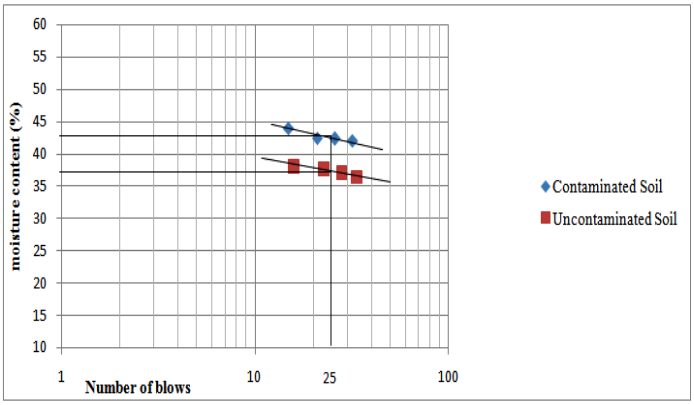

Fig.2.Liquid limit

LL for contaminated soil was found out to be 42.5% and that for uncontaminated soil was found out to be 37.5%.

5.3 Compaction Characteristics:

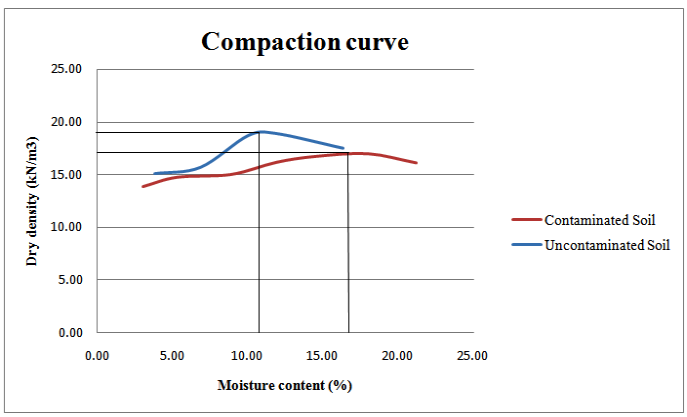

Fig.3.Compaction curve

From the compaction curve, we can observe that OMC for contaminated soil was found out to be 17.75% and that for uncontaminated soil was 12%. MDD of contaminated soil was found out to be 17kN/m^3 and that for uncontaminated soil was found out to be 19kN/m^3.

5.4 Unconfined Compression strength test:

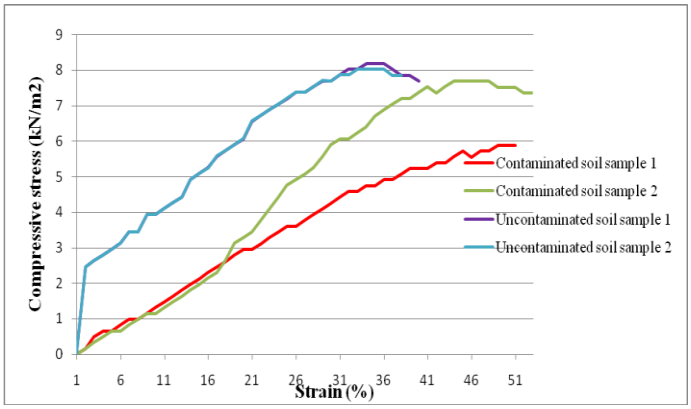

Fig.4.Stress-strain characteristics from UCS test results

From the above graph, we can observe that compressive stress for uncontaminated soil was found higher than that of contaminated soil.

5.5 Direct shear test

5.5.1 Direct shear test for contaminated soil

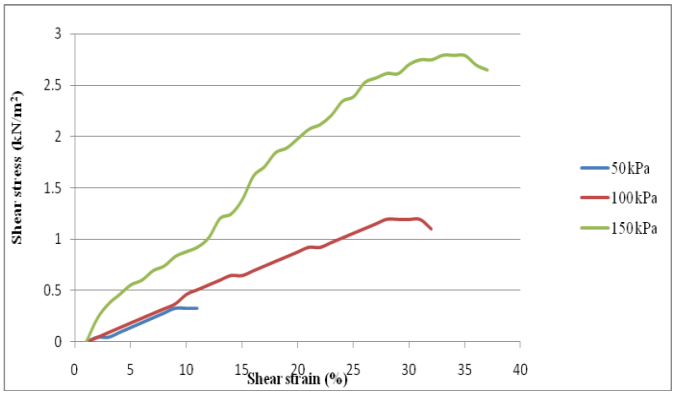

Fig.5.Shear stress v/s strain graph for contaminated soil

5.5.2 Direct shear test for uncontaminated soil

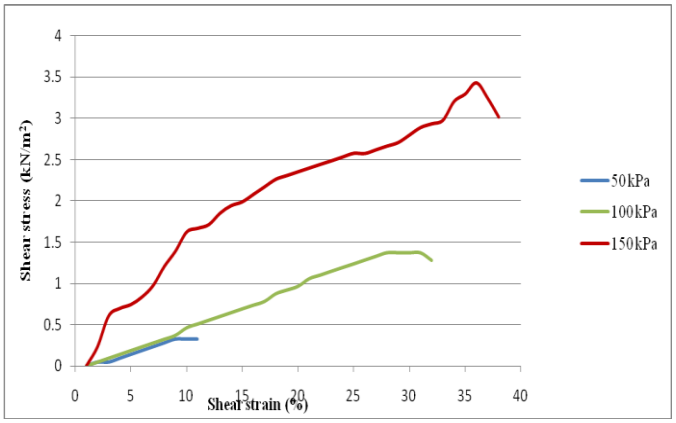

Fig.6.Shear stress v/s strain graph for uncontaminated soil

The direct shear tests conducted for both contaminated soil and uncontaminated soil showed that shear strength of uncontaminated soil is higher than that of contaminated soil.

Table-3: Overall test results

Description	Uncontaminated soil	Contaminated soil
NMC (%)	4.45	17.93
Specific Gravity	1.66	1.7
Liquid limit (%)	37	42.5
Plastic limit (%)	23.31	26.67
Plasticity Index (%)	14.19	15.83
Flow Index (%)	8	8
Toughness Index	1.77	1.978
Soil classification	CI	MI
OMC (%)	12	17.75
MDD (kN/m^3)	19	17
Co-efficient of permeability (cm/s)	2.48 X 10^{-4}	3.86 X 10^{-4}
Cohesion, C (kN/m^2)	15	10
Angle of internal friction, ϕ (°)	22	19
Unconfined compression strength, qu, (kN/m^2)	8.11	6.78
Undrained cohesion, Cu, (kN/m^2)	4.05	3.39

6. CONCLUSIONS

The study has been conducted to compare the characteristics of uncontaminated and contaminated soil, the conclusions is as follows:

1. Chemical test results shows that there was not much variations in pH. Alkalinity, BOD and COD of uncontaminated soil was less than that of contaminated soil. Chloride concentration in uncontaminated soil was found to be greater than contaminated soil, this may be due to seasonal variation also.

2. LL for contaminated soil was found to be 42.5% and that for uncontaminated soil was found out to be 37.5%.

3. Co-efficient of permeability of contaminated soil is 3.84 X 10^{-4}cm/s where as that for uncontaminated soil was found to be 2.48 X 10^{-4}cm/s. This indicates the contamination of soil has lead to increase in porosity which in turn increased permeability of soil.

4. Compaction test results shows that OMC for contaminated soil was 12.0% and that for uncontaminated soil is 17.75%. MDD of contaminated soil was found out to be 17kN/m^3 and that for uncontaminated soil was found out to be 19kN/m^3.

5. From Unconfined Compression Strength test, it is observed that UCS for uncontaminated soil is greater than that of contaminated soil. UCS of uncontaminated soil was found to be 8.11kN/m^2 and that of contaminated soil is 6.78kN/m^2.

6. The direct shear test conducted for both soils showed that shear strength of uncontaminated soil is higher than that of contaminated soil.

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