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Characterization of Soils Near Bellahalli Dumping Site, Karnataka, India

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Abstract:

Municipal solid waste management is one of the major issues in urban cities like Bangalore. Vast development in population along with the economy and rising their living standards have been triggered the creation of enamours amounts of junk, ashes, debris collectively known as solid waste. Due to lack of maintenance of existing landfill site much of it is unserviceable or already ruined immediate causing an outbreak of rage among people. Unacceptable disposal is a hazardous problem advancing in our budding nations since waste directly ends up in open landfill dumping affecting numerous health complications. Soil samples were collected by excavation at different locations in the site by contaminated and uncontaminated soil viz., one right below the landfill and the other about 30m away from the landfill site. The soil samples collected from sites were tested for change in Chemical, physical and geotechnical properties like pH, electrical conductivity, chloride percentage, alkalinity, BOD and COD heavy metals etc. Samples were also tested for geotechnical properties such as liquid limit, plastic limit, shrinkage limit, water content, specific gravity compaction characteristics, permeability, UCS and shear strength etc. and for physical properties like their colour texture etc. Analysis results shown that there is an effect on both physical, chemical and geotechnical properties of soil because of contamination of soil when compared with the uncontaminated soil. Hence in order to predict the change in the property of contaminated soil, long term studied has to be made to analysis the effect on the properties of soil

Key words: Land fill site, Soil sample, physical, chemical, geotechnical properties.

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I. INTRODUCTION

Solid Waste management has been a common problem in today's scenario; almost all of the developed and developing countries are facing the same issue. Municipal solid wastes prefer to non-liquid wastes which emerge from the residential, Industrial, treatment plant sites and commercial activities. They consist of various constituents with

different compositions. Solid wastes are the constituent which are inevitably thrown away are owing to human activities; involving either indirectly or direct usage of natural matter, where large quantities of municipal solid wastes are being generated on a daily activities they are often thrown away and this tends to constitute environmental degradation. The solid waste characteristics generated which varies from country to country. In cities like Bangalore, municipal solid waste management is seen as a major issue of great approach. The contamination caused by municipal solid waste dumps are even seen to be more in the cities where large amount of solid wastes is dumped indiscriminately and thereby, putting pressure on land and also affecting soil properties of their physical, chemical and geotechnical properties. The municipal solid waste generation has been observed to increase periodically in urban areas on account of two high rate of population. The dumping of solid wastes have been changing their color and texture of the receiving soil with their increase in physical geotechnical and chemical constituents. It was found that increase in organic matter content and interactions of the metals with the organic content are the reasons for high values of the tested constituents in soil properties after the refuse is dumped in soil. It also became a serious threat to the groundwater re-sources and soil. The pollution of soil by heavy metal which can cause unfavorable effects on human health, animals and soil potential. Solid waste pollutants Dish up an external force affecting the physical, chemical and geotechnical characteristics of soil ultimately put up towards the poor production of vegetation. The growing level of solid waste now days have become a serious issue in the urban areas of the world.

A. *Objectives*

1. To carry out Reconnaissance survey of study area.
2. To evaluate the impact of municipal solid waste on the properties of soil at a landfill site at Bangalore.

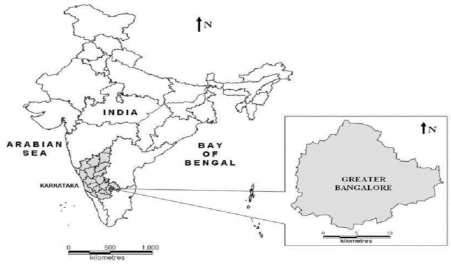


Fig 1. India Map

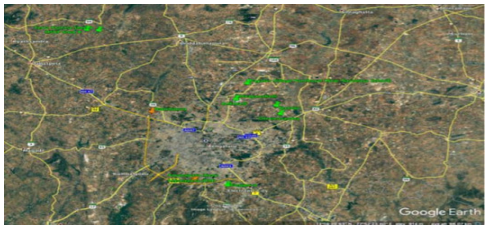


Fig 2: Different dumping site location at Bangalore.

II. LITERATURE REVIEW

G. VenkataRamaiah and S. Krishnaiah (2014) in their study they been collected soil samples from Bangalore open dumped site. Soil sample were collected at every 1.5 m interval (top surface, 1.5 m and 3 m depth from top surface) using auger boring equipment. A total number of 12 samples (three samples at each depth from each location) were

collected and analysed for, their index properties such as specific gravity, moisture content and organic matter of the soil was determined according to the IS code. In their studies they found that the study area has highly undulating topography and predominantly consisting of granites and gneisses which are crisscrossed by pegmatite and are highly jointed.

Sunil Srigirisetty, ThadivalaJayasri, Chitti Netaji(2017) In their studies they collected soil samples from the dumped site, were brought by removing their surface debris and subsurface soil dug to the depth of about 30cm and 1m with a hand auger equipment. Soil samples were taken into the sterile containers and it was labelled. The soil samples were carried to Andhra university laboratory and analyzed for their soil chemical properties. Various Physico-chemical parameters been examined in water samples include, pH, electrical conductivity (EC), total dissolved solids (TDS), total alkalinity (TA), total hardness (TH), calcium, magnesium, potassium, iron, chlorides, turbidity, Nitrates. Similarly soil samples were tested for pH, water soluble salts, organic matter, nitrogen, phosphorus, potassium, iron, water soluble chlorides, water soluble sulphates, calcium carbonate. Their results were compared with BIS standard limits.

T. Subramani, C. Karthikeyan, and S. Priyanka (May 2017): **In their studies they collected the** soil samples were been collected as per standard. The sampling of soil were done by using hand augur equipment .The augur was used to bore and to hold the desired depth. Temperature and suspended solids were also been determined by using various standard methods. MSW landfills also can be accepted contaminated soil from gasoline spills, conditionally exempted hazardous waste from Industries, small quantities of hazardous waste from their households, and other toxic wastes were including Industrial facilities may be utilized their own captive landfill to dispose of non-hazardous waste from their processes, such as sludge from paper mills and wood waste from their wood processing facilities.

E. I. UGu, A.C. Ekeleme, P. O .Awatere, H.O.Oszioko, U. Osinachi (Oct 2017) in their studies they collected soil samples were collected from municipal solid waste at dumping site. Disturbed soil samples were collected at the site Whereas, for the un-contaminated soil, the control trial pit were located with almost precaution so as to be far from leachate emanating and from theire decomposition of the municipal solid waste and from theire horizontal direction of flow from the leachate. The geotechnical properties tested for their particle size distribution, natural moisture

content, consistency limits, maximum dry density, optimum moisture content and specific gravity etc.

Karthik G (2018), in their studies, Excavation was done for the two different locations in the landfill site in order to collect the soil samples. The samples were collected in separate polythene bags that was labelled and transported to the geotechnical laboratory for testing the soil sample. Chemical tests were conducted for determine of their chemical properties like pH value, BOD test, COD test Chloride content determination, Alkalinity test and whereas geotechnical tests were conducted to analyses the specific gravity, Grain size determination, liquid limit and plastic limit, Compaction test, Unconfined Compression Strength Test and Permeability test.

S.A. Nta, M. J. Ayotamuno, A. H. Igoni, and R. H. Okaparanma (2020),' In their studies they collected four soil profile samples been collected at a specified distance (10, 20, 30 and control 100 m away) from the Municipal Solid Waste dumping site and determine the characterized physic-chemical and geotechnical properties of the soil. Analytical methods used for soil samples been chosen based on the parameters of interest. The collected soil samples were air-dried Analytical methods used for soil samples were taken based on the parameters. The collected soil samples were air-dried and their Geotechnical properties of their Attterberg limits, specific gravity and hydraulic conductivity.

S. P. Jeyapriya, M. K. Saseetharan In their studies they collected the study was done in Coimbatore situated in Tamilnadu. Soil samples were collected by excavating the pits each pit and has been excavated for the depth of 120cm and soil been collected at every 30cm intervals. Then the soil is passed through 2mm sieve which is subjected for their determination of physical, physic-chemical, chemical

Parameters. from this study they have been found that soil texture were altered due to decomposition of their organic matter, soil colour has been changed from pale brown to dark brown, and an increase in the pH value is observed due to the presence of CO3, HCO3, Na, K in the deposited wastes, Electrical conductivity varied from 2.74dS/m to 1.24dS/m this high EC is due to presence of soluble salts in MSW, High cation exchange capacity at the surface and it's been decreased with increase in depth and carbon content at the top of the soil was 0.16% before placing solid waste and after placing solid waste it is 1.68% , Total nitrogen content decreases with increase in their depth, compared to Mg content cation Ca was more in soil after placing the solid waste, concentration of phosphorus was high in their soil after placing the refuse, the metals were like Cu, Mn, Fe and Zn shown high concentration at

the top surface , Cadmium content decreased with their increase in the depth of the soil.

Evangelin Ramani Sujatha, Gurucharan R, Ramprasad C, Sornakumar V (2013) the study area was located in Ariyamangalam that is 10 km within the east direction from Trichy, soil samples were collected from three trial pits at Depth of 0.5m, 1.0m and 1.5m. First two trail pits were located at around dump site, third pit was located within the dump site. These samples were analyzed for specific gravity test, natural moisture content, partical size analysis, consistency, compaction, permeability, triaxial and consolidation test. The result of this study was shows that MSW lowers their specific gravity, and increases the natural moisture content, increases the fine particle content, lowers the maximum dry density with their higher optimum moisture content and lowers the cohesion and angle of internal friction, increase the coefficient of permeability, coefficient of consolidation and coefficient of volume Compressibility of the soil.

Utpal Go swami and H. P. Sharma this study has been done in Guwahati which is located in Assam. The soil samples was collected from four different depths of 0-15, 15-30, 30-45, 45-60 cm. The preparation and analysis of soil samples were done according to the Piper. the results of this study was MSW contains more primary and secondary nutrients than the soluble salts, pH of samples were found to be >7 and EC value increased from 0.048-0.531dS/m, soil samples shown the high content of N, K&P, MSW was found to be in heterogeneous in nature, physic-chemical characters of MSW depends on nature of waste materials.

III. Study Area

Before, garbage was being dumped in Mandur, near Bengaluru, but as the residents staged a protest due to the increasing groundwater contamination as a consequence of unchecked dumping, officials had to choose Bellahalli as the dumping yard. Over 200 acres Abandoned quarry, and currently receiving mixed waste which is dumped. It is interesting to note that the Bangalore generates 5,700 tons of garbage on an everyday basis. Out of this, where only 400 tons goes to waste processing units. About 200 tons is sent for a waste processing at a processing unit in Doddaballapur. The remaining garbage finds its way to Bellahalli and the landfill at Bellahalli has been almost filled, and have taken up some rectification works, but it seems to be unsatisfactory. Bellahalli is the only landfill for the Bangalore at present. Bellahalli and Mittaganahalli located about 25 kms from North Bangalore centre off to the Bellary road. The Landfill extend over 400 acres. it has now become as Only major dumping site for mixed solid waste and its receives almost 200 garbage trucks daily and accounting for almost 1600 tons waste per day – which has been roughly half of the waste generated in Bangalore during the period. While the city households

generates nearly 4,500 tons of mixed waste per day, the BBMP engages 600 trucks to dump 2,500 tons of waste at Bellahalli landfill.

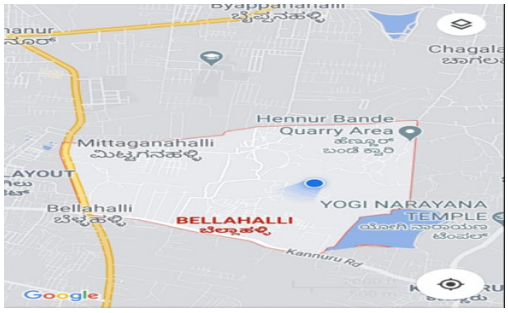


Fig 3: Location of Bellahalli Landfill Site

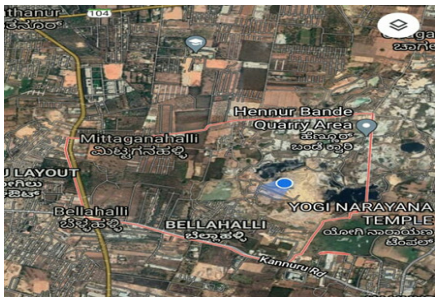


Fig 4: Satellite location of Bellahalli Landfill Site

III. Methods & Methodology

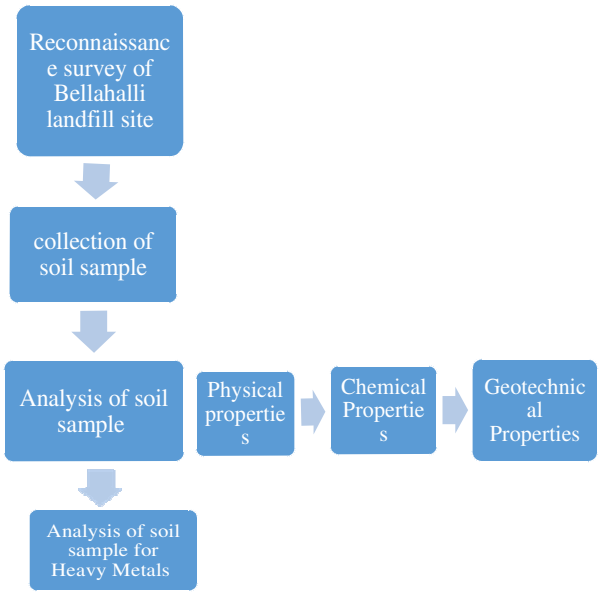


Fig 5: Flow Chart

B. *Soil Sampling and Analysis*

The soil samples for various tests were prepared as per ASTM Standard and Indian standard methods. The sampling of soil is done during month of March, prior to rainy season, so that rain water may not affect the properties of soil. The contaminated samples were collected within the site from four trial pits underlying the MSW dump at depth of 0.5m, below ground level. Excavation of samples are done at the interval of every 20m from previous sample for comparison, uncontaminated natural soil samples were also taken from a distance of 2 km from the dump site. Soil samples are extracted through augur boring, sieved to<4.75mm to get homogenous soil. Careful transportation of samples is attained by packing soil samples in plastic bags.

Fig 6: Soil Collection

C. Following physical tests were conducted:

1. Soil Colour.

2. Soil Texture

D. Following Chemical Tests Were Conducted

1. Ph
2. Ec
3. Alkalinity of caco3
4. Organic Carbon
5. Total Nitrogen
6. Calcium
7. Magnesium
8. Sodium
9. Potassium
10. Phosphorous
11. Copper
12. Manganese
13. BOD
14. COD

E. Following Geotechnical Tests were conducted

1. Determination of specific gravity.
2. Grain size analysiS
3. Determination of liquid limit
4. Compaction Test
5. Unconfined Compression test
6. Moisture content
7. Direct shear

F. Following Heavy Metals Tests were conducted

1. Iron
2. Lead
3. Cadmium
4. Zinc
5. Nickel

V RESULTS AND DISCUSSION

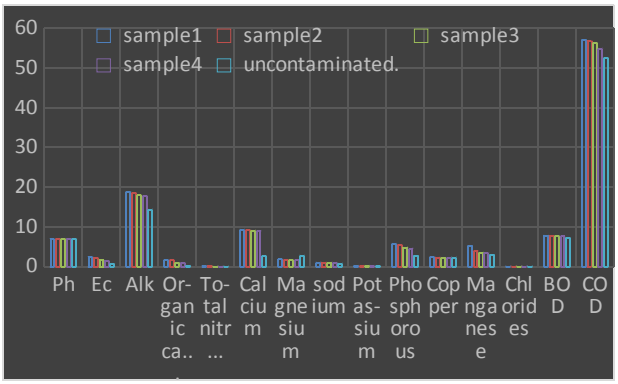
Table 1: Physical Characteristics Test Report

Characteristics	Sample 1	Sample 2	sample 3	sample 4	Uncontaminated.
Soil texture	Sandy clay	Sandy clay	Sandy loom	Sandy loom	Sandy
Soil colour	Pale brown	Pale brown	Pale brown	Pale brown	Pale brown

H. Chemical Properties

Table 2: Chemical Test Report

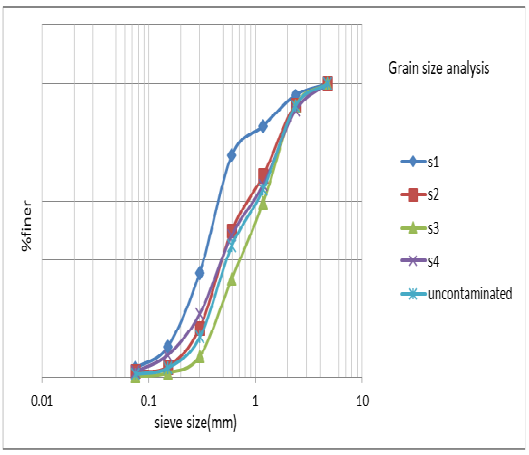
Characteristics	**sample1**	**sample2**	**sample3**	**sample4**	**Un-contaminated.**
Ph.	**7**	**6.9**	**6.92**	**6.94**	**6.9**
Ec	**2.4**	**2.1**	**1.67**	**1.37**	**0.68**
Alkalinity of caco3	**18.8**	**18.5**	**17.9**	**17.8**	**14.35**
Organic carbon	**1.62**	**1.58**	**0.91**	**0.88**	**0.17**
Total nitrogen	**0.14**	**0.078**	**0.006**	**0.005**	**0.006**
Calcium	**9.28**	**9.16**	**9.06**	**8.9**	**2.59**
Magnesium	**1.76**	**1.69**	**1.58**	**1.55**	**2.74**
sodium	**1**	**0.99**	**0.97**	**0.965**	**0.76**
Potassium	**0.179**	**0.175**	**0.169**	**0.168**	**0.079**
Phosphorous	**5.72**	**5.42**	**4.81**	**4.56**	**2.71**
Copper	**2.36**	**2.28**	**2.18**	**2.15**	**2.29**
Manganese	**5.19**	**3.89**	**3.52**	**3.45**	**2.95**
Chlorides	**0.04**	**0.038**	**0.0356**	**0.032**	**0.0262**
BOD	**7.8**	**7.7**	**7.65**	**7.58**	**7.2**
COD	**57.1**	**56.8**	**56.28**	**54.9**	**52.51**



Graph 1: Chemical Properties.

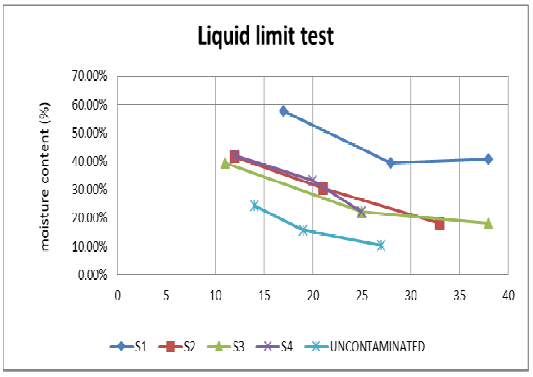
Test results shown here have not much variations in ph. Alkalinity, BOD and COD of uncontaminated soil is high than that of contaminated soil. COD content of uncontaminated soil is found to be greater than contaminated soil, and effect of heavy metals on the contaminated soil is more when compared to uncontaminated soil.

I.Grain size analysis:



Graph 2: Grain size distribution curve

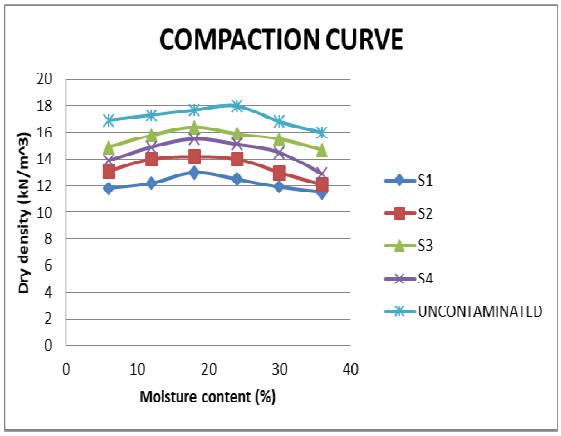
J. Liquid Limit of uncontaminated and contaminated soil:



Graph 3: Liquid Limit Test

Liquid Limit of Contaminated soil (S1, S2, S3 and S4) is more than the uncontaminated soil.

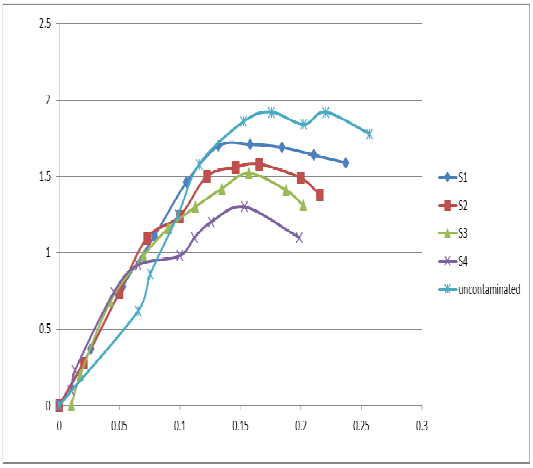
K. Compaction Characteristics:



Graph 4: Compaction curve

From compaction curve, we can observe that the OMC for uncontaminated soil was found out to be 17% and that for contaminated soil was 22%. MDD of contaminated soil was been found that15kN/m3 and that for uncontaminated soil was found out to be 18.9kN/m3.

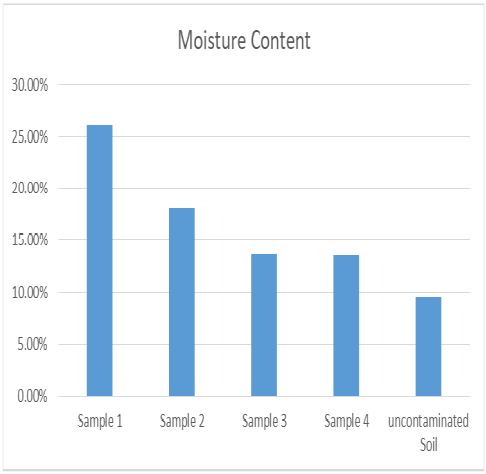
L. Unconfined Compression strength test:



Graph 5: Stress-strain characteristics from UCS test results.

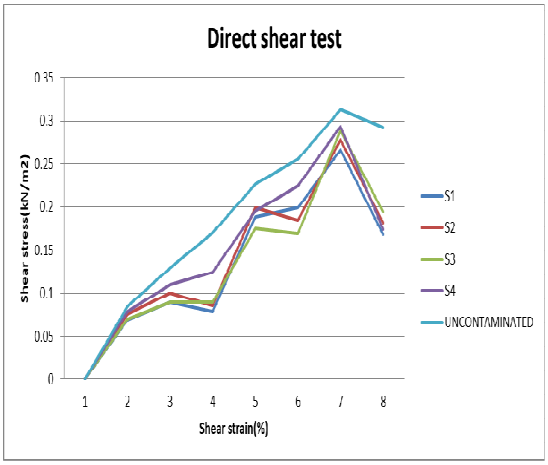
From the above graph we can observe that compressive stress for uncontaminated soil was found to be higher than that of the contaminated soil (S1 S2 S3 S4).

M. Moisture content



Graph 6: Moisture Content

N. Direct shear test

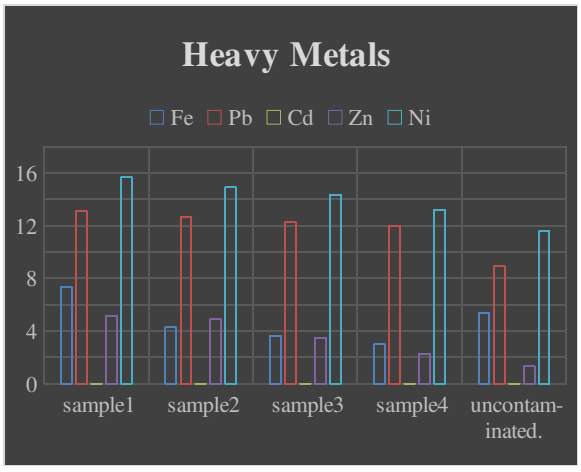


Graph 7: Shear stress v/s strain graph

V. Heavy Metals

Soil Metal	sample1	sample 2	sample3	sample4	Uncontaminated.
Fe	7.38	4.29	3.65	3.01	5.4
Pb	13.11	12.68	12.25	11.98	8.92
Cd	0.0159	0.0132	0.012	0.01	0.009
Zn	5.19	4.89	3.51	2.28	1.35
Ni	15.68	14.92	14.38	13.21	11.6

Table 3: Heavy Metals



Graph 8: Heavy metals

O. Overall Test Results

Table 4: Overall Test Results

Description	Contaminated	uncontaminated
NMC%	17.86%	9.48%
Specific gravity	2.2	1.9
Liquid Limit	42.5	37.3
Plastic Limit	25.4	23.2
Plasticity Index	14.83	13.3
Flow Index	8	7.9
Toughness Index	1.76	1.63
Heavy Metals Fe Zn, Ni	4.58,4.30,14.554	5.0,1.35,11.6
Pb, Cd,	12.50,	8.92
OMC%	17%	17%
MDD (kN/m3)	15 (kN/m3)	18.9 (kN/m3)
Co-efficient of permeability (cm/s)	2.78 X 10-4 (cm/s)	3.36 X 10-4(cm/s)
Cohesion, C (kN/m2)	11(kN/m2)	14(kN/m2)
Angle of internal friction, ϕ (°)	20	23
Unconfined compression strength, qu, (kN/m2)	6.5(kN/m2)	7.9(kN/m2)
Undrained cohesion, Cu, (kN/m2)	3.2(kN/m2)	4.5(kN/m2)

VI CONCULSION

1. Chemical test results shows that there was not much variations in pH. Alkalinity, BOD of uncontaminated soil was less than that of contaminated soil. COD and heavy metals has higher variation when compared to contaminated and uncontaminated soil.
2. Chloride concentration in uncontaminated soil was found to be greater than contaminated soil.
3. LL for contaminated soil was found to be higher than uncontaminated soil was found out. Co-efficient of permeability of contaminated soil is less when compared to uncontaminated soil. This indicates the contamination of soil has led to increase in porosity which in turn increased permeability of soil.
4. Compaction test results shows that OMC for contaminated soil was 22 and that for uncontaminated soil is 17%. MDD of contaminated soil was found out to be less than the uncontaminated soil.
5. From Unconfined Compression Strength test, it is observed that UCS for uncontaminated soil is greater than that of contaminated soil.
6. uncontaminated soil was found to be higher than the contaminated soil
7. 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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