

Effect of Leachate on Index Properties of Soil

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***Abstract*—Leachate is liquid waste produced from domestic households or industrial waste products. Municipal solid waste (MSW) is the main origin of leachate in urban areas. Soil pollution caused due to dumping of municipal solid waste at dump yards directly on surface of land. In India cities are very densely populated hence it becomes very tough to manage municipal solid waste. It becomes quite challenging because of increasing industrialization as well as increasing modernization. Unscientific disposal of MSW on land leads to soil pollution which results in loss of strength of soil. Here in my project work an attempt is made to understand the pollutants present in MSW which will harm the physical properties and chemical properties of soil. Precipitation which infiltrates by MSW leach all the constituents from decomposed waste mass and while going down causes subsurface soil to polluted by organic as well as inorganic salts.**

In this study the geotechnical parameters of leachate affected soil are studied in detail and are compared with different types of soil. In the same time chemical properties of the same soil are analyzed and results are delivered. Leachate was collected from MSW dump yard of Bidar which is located near Sultanpur village. Geotechnical parameters like Free Swelling Index, Grain Size Analysis, Liquid limit, Plastic limit, Plasticity index, California Bearing Ratio, and Shear strength of leachate affected soil are determined and are compared with the results of that of uncontaminated soil sample of different type of soils. Chemical properties of leachate i.e Biochemical Oxygen Demand, COD, PH, Magnesium hardness, Zinc, Chloride, Iron, etc are determined.

The project comprises of comparative analysis of three different soil samples in order to bring out the contrast in the change in properties of the affected soil. Vast research is being done in the field of environmental science to counter the problem of leachate and to treat the affected soil. As it is known that leachate is not any special structured chemical compound nor it is a highly reactive nuclear waste, it is just liquid which through the leaching action collects all the ingredients presents in that layer it passes by. It is a naturally occurring liquid which is so reactive that it can completely deteriorate the soil and make it barren. Leachate affected soil is stabilized with the Rice Husk to improve its strength properties.

Keywords— leachate, rice husk, black cotton, CBR,Atterberg's limit,OMC,MMD

I. Introduction

More than 80 percent of nation's waste is disposed directly on land. Based on experience observed from the past in India and across the globe the land filling is concluded as most economical way of solid waste disposal. Planning and designing of landfill has evolved as a complicated technology. It is more sophisticated design and it will continue until landfills are undivided part of solid waste management.

Landfills should be designed in such a way that their effect on environment and health should be brought to minimal levels which will diminish local, regional and national concerns. Excellent design and healthy construction of a landfill should be incorporated with modern technology which will safeguard release of contaminants into atmosphere, surface water and underground water reducing concerns in its entire operating system. Many geological as well as hydrological engineering concerns shall be minimizes by a good landfill design. Composite liners must be placed carefully at the bottom which contains 3 to 5 feet of re compacted clay liner over lain by a geo membrane.

Characteristics of leachate will differ depending upon the age of the leachate and composition of the dumping yard used. The leachate is mainly generated by the process of precipitation that percolates through waste deposits at landfill site. And when it comes in contact with decomposing solid waste the flowing water will be contaminated and when itr goes out of the waste material it will be known as leachate.

Leachate affected soil can be used by stabilizing process. Stabilization can be done by various ways. One of the best ways is adding Rice husk to the waste soil. Rice husk ash (RHA) is by product generated from the production of white rice. Stabilizing the leachate affected soil with Rice husk will improve the shear strength and all other geotechnical parameters of soil will be improved. So by this we can use the polluted soil by stabilizing for the purpose of constructions like embankments etc.

II. Materials and Methodology

A. *Materials*

Materials used for this project are as following.

- Leachate affected soil sample.
- Uncontaminated black cotton soil.
- Uncontaminated laterite soil.
- Liquid waste collected from industrial area.
- Rice husk.

1) Leachate affected soil: Soil sample was collected from MSW dump site of Bidar which is located near Sultanpur village. Garbage was placed layer by layer which includes soil also. The sample was collected from 1 to 1.5 meter depth.

TABLE I. Physical Properties of Leachate Affected Soil

S No	Properties	leachate soil
1	FSI(%)	60
2	Specific gravity	1.6
3	LL (%)	54
4	PL (%)	17.77
5	SL(%)	15.20
6	PI	36.23
7	MDD (g/cc)	3.15
8	OMC (%)	25.25
9	CBR (%) soaked	2.12

2) Black cotton soil: Black cotton soil used in this project was collected from a excavation that is carried out at major bridge near Bidar karanja dam, soil collected from the depth of 1.5m.

TABLE II. PHYSICAL PROPERTIES OF B.C SOIL

S No	Properties	leachate soil
1	FSI(%)	60
2	Specific gravity	1.6
3	LL (%)	54
4	PL (%)	17.77
5	SL(%)	15.20
6	PI	36.23
7	MDD (g/cc)	3.15
8	OMC (%)	25.25
9	CBR (%) soaked	2.12

3) Black cotton soil: Black cotton soil used in this project was collected from a excavation that is carried out at major bridge near Bidar karanja dam, soil collected from the depth of 1.5m.

TABLE III. PHYSICAL PROPERTIES OF B.C SOIL

Sl No	Properties	B.C soil
1	FSI (%)	40
2	Specific gravity	2.4
3	LL (%)	65
4	PL (%)	45.21
5	SL (%)	17.42
6	PI	19.79
7	I S Soil classification	CH
8	MDD (g/cc)	1.50
9	OMC (%)	25
10	CBR (%) Soaked	1.3

4) Laterite soil: Laterite soil used in this project work was brought from the site of minor bridge construction near Bidar, soil was collected from the depth of 1.5m.

TABLE IV. PHYSICAL PROPERTIES OF LATERITE SOIL

Sl No	Properties	Soil
1	FSI (%)	14
2	Specific gravity	2.64
3	LL (%)	32
4	PL (%)	27.12
5	SL (%)	18.12
6	PI	5.68
7	I S Soil classification	MH
8	MDD (g/cc)	2.04
9	OMC (%)	9.4
10	CBR (%) Soaked	19.63

5) Liquid Waste Collected From Industrial Area: Liquid waste was collected from Kolar Industrial area which is located near Bidar. The sample was taken to laboratory and chemical properties of sample were tested in laboratory. Chemical composition of liquid waste has a adverse effect on physical and chemical properties of soil.

TABLE V. CHEMICAL COMPOSITION OF LEACHATE

Sl No	Properties	B.C soil
1	pH value	6.2
2	COD	22600
3	BOD	10900
4	Fatty acids	5688
5	Total organic carbon	18.12

Photo showing synthetic Leachate Synthetic leachate was collected from the waste pond and tested in laboratory. It was found that there are many hazardous chemicals as well as metals which are present in leachate. There was high levels of toxin found in water. Generally MSW landfill contains heavy amount of organic matter and ammonia nitrogen heavy metals and organic as well as inorganic salts.

TABLE VI. PHOTO SHOWING SYNTHETIC LEACHATE

Sl No	Properties	B.C soil
1	E.C (ds/m)	13.24
2	Na^{+} (milligram/litre)	850
3	Ca^{+2} (milligram/litre)	1700
4	Mg^{+2}(milligram/litre)	40
5	K^{+}(milligram/litre)	175
6	Cl^{-}(milligram/litre)	3420
7	So_4^{-2}(milligram/litre)	141
8	NO_3^{-}(milligram/litre)	38
9	Cu(milligram/litre)	10
10	Zn(milligram/litre)	110
11	Pb(milligram/litre)	4
12	Cd(milligram/litre)	1
13	Ni(milligram/litre)	1.1
14	Hg(milligram/litre)	0.8
15	TDS(milligram/litre)	15500

6) Rice husk: Rice husk is a byproduct produced from milling at the time of production of rice from seeds. Approximately around 0.28 kg of rice husk is generated in the production of 1kg rice. This produced rice husk when it is subjected to burn it will be used as a soil stabilizer. Here rice husk will be added with leachate affected soil to strengthen it and to improve its shear strength.

TABLE VII. CHEMICAL AND PHYSICAL COMPOSITION OF RHA

Sl No	Properties	Soil
1	Al_2O_3	4.9
2	SiO_2	67.3
3	Fe_2O_3	0.95
4	CaO	1.36
5	MgO	1.81
6	Loss of ignition	17.78
7	Specific gravity(Gs)	1.98
8	MDD(g/cc)	0.95
9	OMC(%)	47
10	CBR (Soaked)%	12.95
11	CBR (UN Soaked)%	18.5

B. Methodology

First of all the site selection for collecting sample will be identified. There are many dumping sites where MSW is directly taken and dumped on to open land. Freshly constructed landfill site will not yield you the proper results. Aged landfill site will be chosen in order to get appropriate results. Here I have collected the waste sample from almost around 7 years old landfill site.

Municipal Solid Waste i.e Leachate is tested for basic tests and after that it will be replaced with 10%, 20%, 30% by black cotton soil and the geotechnical parameters will be tested in tha laboratory. Leachate will be then replaced with10%, 20%, 30% by laterite soil and the geotechnical parameters will be tested in tha laboratory, results obtained are compared with each other and results are discussed.

For the purpose of strengthening the weak soil that is leachate affected soil, Rice husk ash (RHA) will be added to the soil for the purpose of stabilizing the soil sample and the geotechnical tests are conducted in the laboratory and increase in the strength of soil are observed. Rice husk will be added in 10%, 20%, 30% and 50% and difference will be observed. LL, PL, PI, are tested and results were discussed. Water content (OMC) and dry density (MDD) are obtained by conducting modified proctor test. CBR test is conducted and characteristics of soil when subjected to mixing with RHA will be examined. Rice husk ash is brought from Raychur rice mill.

Chemical combination of synthetic leachate is tested from chemical as well as environmental laboratories. Ph, chemical oxygen demand, total dissolved solids and many other properties like metal content etc will be determined and their effect on uncontaminated soil will be understood. Hazardous chemicals present in synthetic leachate which will pollute good soil and which will affect the ground water table will be understood properly.

III. RESULTS AND DISCUSSION

A. OMC and MDD results for Leachate affected soil replaced by different percentage of soil and Rice husk

Leachate affected soil is mixed with different percentage of black cotton soil which varies from 10 to 30 percent with a rise of 10% per interval. Heavy compaction tests were conducted to determine OMC and MDD and the results are discussed.

It is again mixed with the same combination of laterite soil and OMC and MDD are determined with the help of determined OMC and MDD we will further proceed to calculate California bearing ratio from which we may come to know the shear strength of soil.

TABLE VIII. OMC AND MDD FOR LEACHATE WITH VARIATION OF SOIL PERCENTAGE

SL.NO	Description	MDD (g/cc)	OMC (%)
1	Leachate + 10% B.C soil	1.930	8.20
2	Leachate + 20% B.C soil	2.04	9.20
3	Leachate + 30% B.C soil	2.220	9.40
4	Leachate + 10% Laterite soil	4.1	12.8
5	Leachate + 20% Laterite soil	3.0	13.9
6	Leachate + 30% Laterite soil	4.1	12.45
7	Leachate + 10% Rice husk	1.345	36.48
8	Leachate + 20% Rice husk	1.6	38.1
9	Leachate + 30% Rice husk	1.61	37.85
10	Leachate + 50% Rice husk	1.9	41.25

TABLE IX. TABULAR COLUMN AND CALCULATION FOR OMC AND MDD

Sl No	Trial No.	1	2	3	4
A	Wt.of wet soil + mould	10450	10865	11158	11259
B	Wt.of wet soil (B = A-L)	4668	5083	5376	5477
C	Wet density of soil, (C=B/V)	2.075	2.259	2.389	2.434
D	Container No.	**A-36**	**A-37**	**A-38**	**A-39**
E	Wt.of container	53.61	56.75	59.12	57.54
F	Wt.of wet soil+Container	153.77	161.07	166.54	171.19
G	Wt.of dry soil+Container	149.73	155.01	158.48	160.77
H	Wt.of water(L=F-G)	4.04	6.06	8.06	10.42
I	Wt.of dry soil(M=G-E)	96.12	98.26	99.36	103.23
J	Moisture content [J = 100X(L/M)]	4.20	6.17	8.11	10.09
K	Dry density[K=100x(F/(100+N)]	1.991	2.128	2.210	2.211

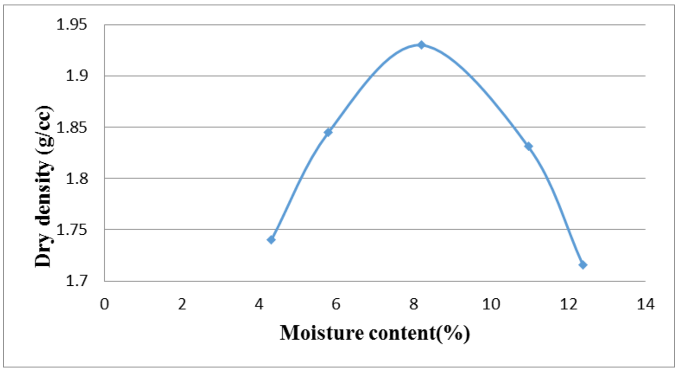

Fig. 1. MDD and OMC for Leachate replaced by 10% of B.C soil.

Fig. 1. Gives the MDD of 1.930g/cc and OMC of 8.20% when 10% of B.C soil is added to Leachate.

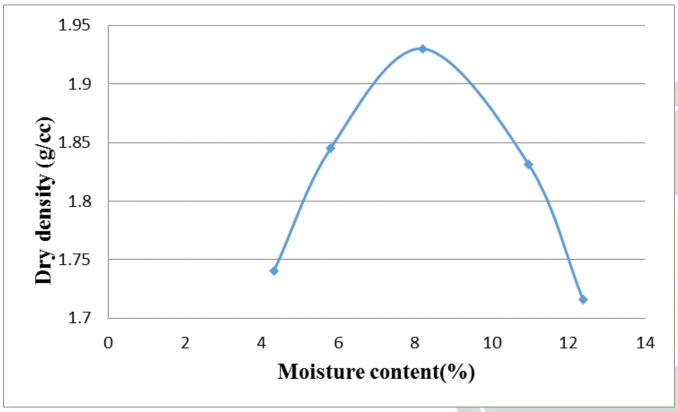

Fig. 2. MDD and OMC for Leachate replaced by 20% of B.C soil.

Fig. 2. Gives the MDD of 2.04 g/cc and OMC of 9.20% when 20% of B.C soil is added to Leachate.

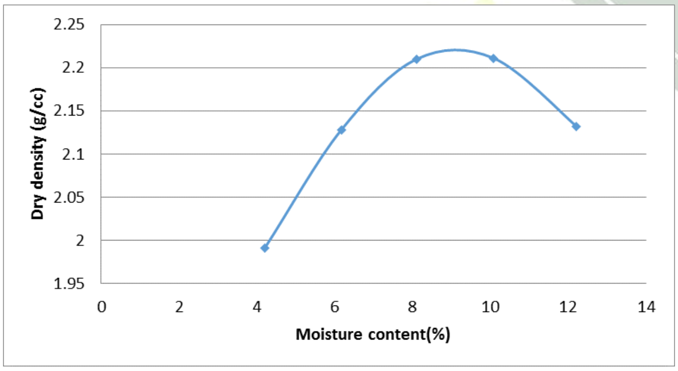

Fig. 3. MDD and OMC for Leachate replaced by 30% of B.C soil.

Fig. 3. Gives the MDD of 2.220 g/cc and OMC of 9.40% when 30% of B.C soil is added to Leachate.

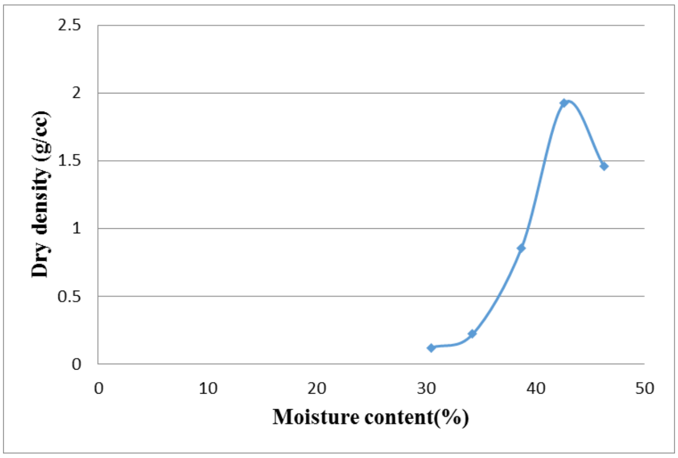

Fig. 4. MDD and OMC for Leachate replaced by 10% of laterite soil.

Fig. 4. Gives the MDD 4.1 g/cc and OMC of 12.8% when 10% of Laterite soil is added to Leachate.

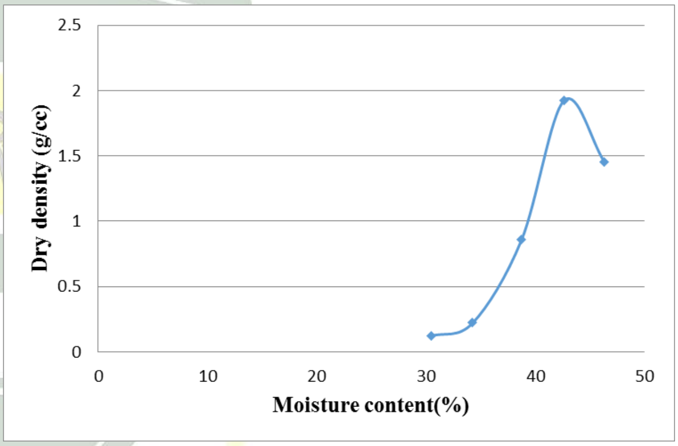

Fig. 5. MDD and OMC for Leachate replaced by 20% of laterite soil.

Fig. 5. Gives the MDD 3.0 g/cc and OMC of 13.9% when 20% of Laterite soil is added to Leachate.

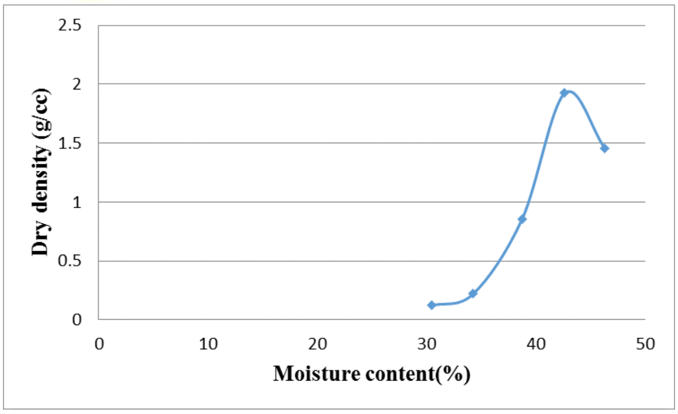

Fig. 6. MDD and OMC for Leachate replaced by 30% of laterite soil.

Fig. 6. Gives the MDD 4.1 g/cc and OMC of 12.45% when 30% of Laterite soil is added to Leachate.

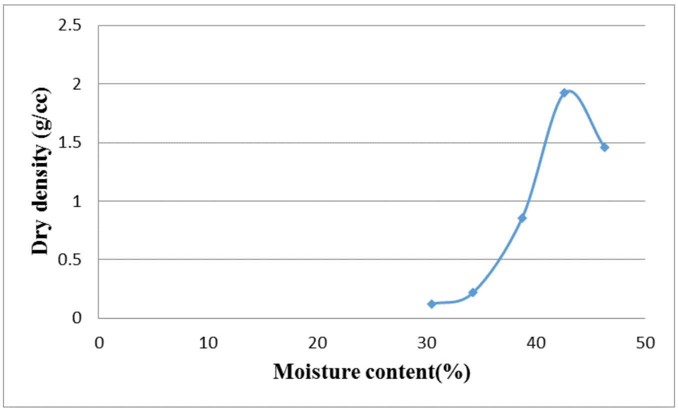

Fig. 7. MDD and OMC for Leachate replaced by 10% of RHA.

Fig. 7. Gives the MDD 1.345 g/cc and OMC of 36.48% when 10% of RHA is added to Leachate.

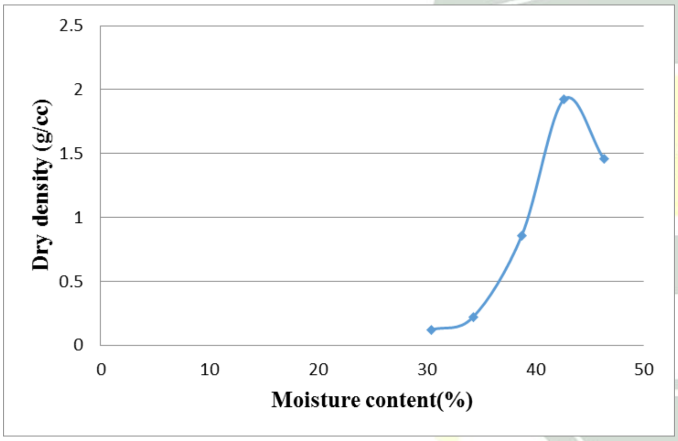

Fig. 8. MDD and OMC for Leachate replaced by 20% of RHA.

Fig. 8. Gives the MDD 1.6 g/cc and OMC of 38.1% when 20% of RHA is added to Leachate.

MDD and OMC for Leachate replaced by 30% of RHA

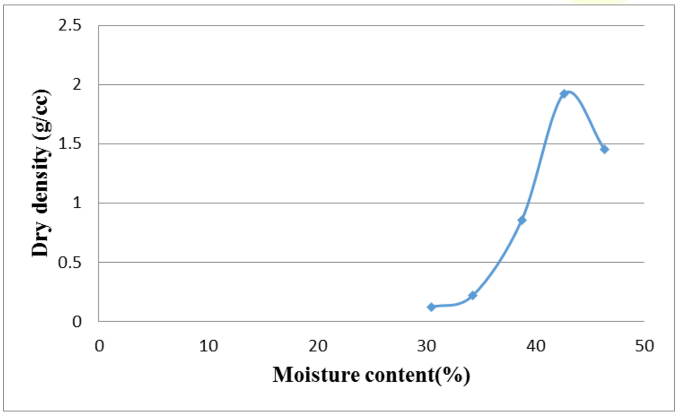

Fig. 9. MDD and OMC for Leachate replaced by 20% of RHA.

Fig. 9. Gives the MDD 1.61 g/cc and OMC of 37.85% when 30% of RHA is added to Leachate.

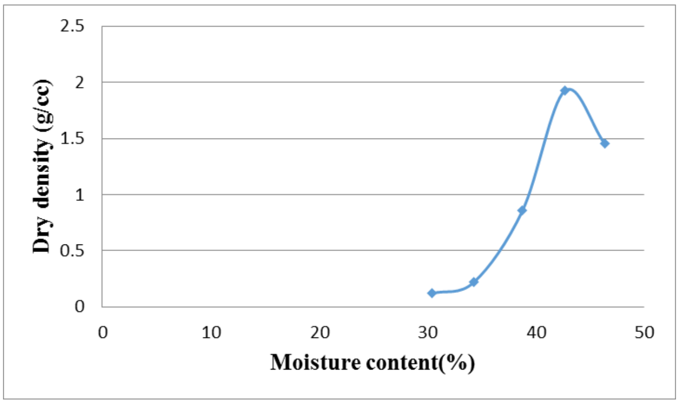

Fig. 10. MDD and OMC for Leachate replaced by 50% of RHA.

Fig. 10. Gives the MDD 1.9g/cc and OMC of 41.25% when 50% of RHA is added to Leachate.

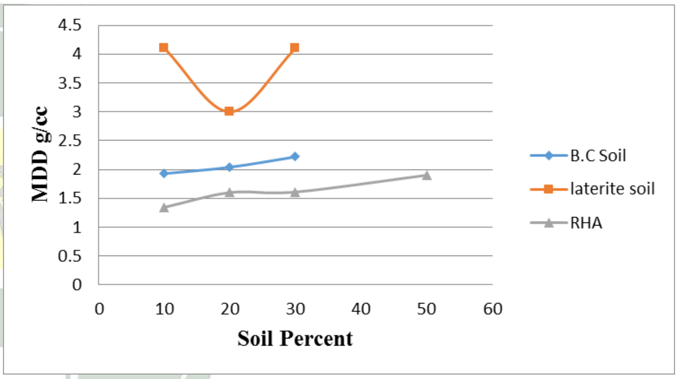

Fig. 11. MDD Variation.

Fig. 11. Shows the variation in MDD when Leachate is replaced by different types of soils in different percentage.

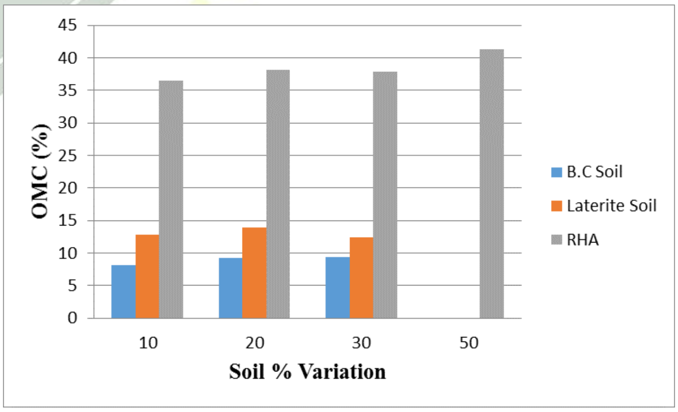

Fig. 12. OMC Variation.

Fig. 12. Shows the variation in OMC when Leachate is replaced by different types of soils in different percentage.

From the above obtained results from graph it can be seen that the OMC has increased reasonably when the leachate is blended with Rice husk. And therefore it can be used as a stabilizer to improve the shear strength parameters of soil.

B. *Atterberg's limits*

TABLE X. ATTERBERG LIMITS FOR LEACHATE REPLACED WITH VARIOUS PERCENTAGE OF B.C SOIL

SL. NO	Replacement of B.C soil (%) in Leachate	LL	PL	PI
1	10%	39	18	21
2	20%	45	20	25
3	30%	55	20	35

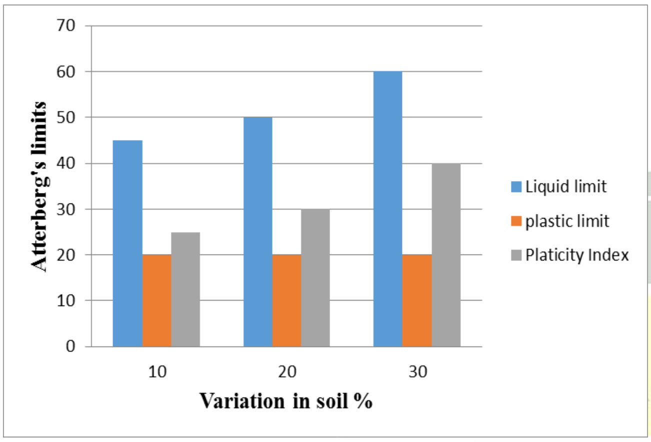

Fig. 13. Showing atterberg's limits when Leachate replaced by B.C soil.

TABLE XI. ATTERBERG LIMITS FOR LEACHATE REPLACED WITH VARIOUS PERCENTAGE OF LATERITE SOIL

SL. NO	Replacement of Laterite soil (%) in Leachate	LL	PL	PI
1	10%	45	20	25
2	20%	50	20	30
3	30%	60	20	40

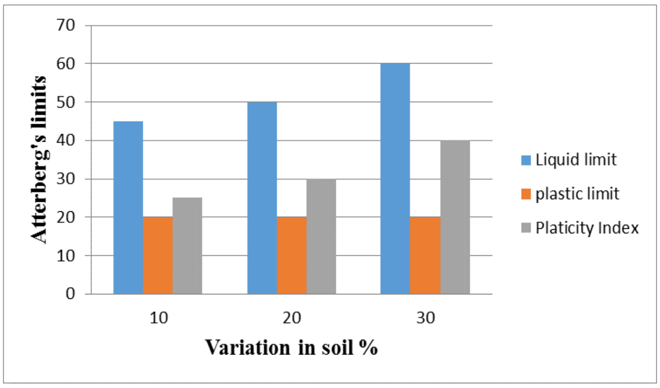

Fig. 14. Showing atterberg's limits when Leachate replaced by oLaterite soil.

TABLE XII. ATTERBERG LIMITS FOR LEACHATE REPLACED WITH VARIOUS PERCENTAGE OF RHA

SL. NO	Replacement of RHA (%) in Leachate	LL	PL	PI
1	10%	61	25	36
2	20%	65	28	37
3	30%	68	25	43
4	50%	70	30	40

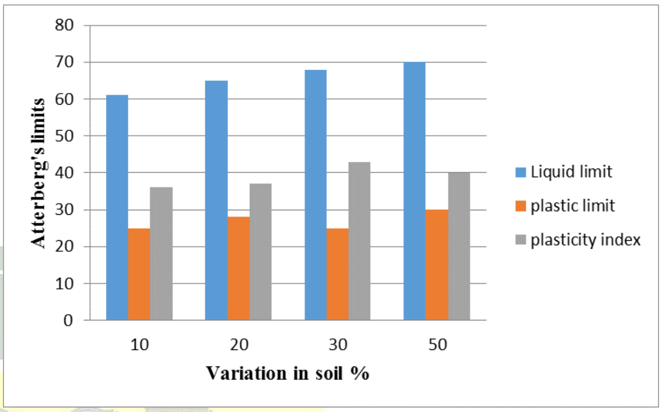

Fig. 15. Showing atterberg's limits when Leachate replaced by RHA.

C. *CBR test results*

TABLE XIII. CBR TEST RESULTS

SL.NO	Description	CBR%
1	Leachate + 10% B.C soil	19.81
2	Leachate + 20% B.C soil	20.78
3	Leachate + 30% B.C soil	21.16
4	Leachate + 10% Laterite soil	16.54
5	Leachate + 20% Laterite soil	17.89
6	Leachate + 30% Laterite soil	19.05
7	Leachate + 10% Rice husk	15.87
8	Leachate + 20% Rice husk	16.74
9	Leachate + 30% Rice husk	19.72
10	Leachate + 50% Rice husk	20.49

IV. OBJECTIVE AND SCOPE

- To understand the effect of Municipal solid waste Leachate and synthetic leachate on physical and chemical properties of uncontaminated soil sample.
- To determine and gain knowledge about Comprehensive geotechnical parameters of the soil, this includes its index and engineering properties.
- To determine all significant changes in the physical properties of geo/membranes due to captivation in actual landfill.

- To understand the significance of dumping solid waste on land. And to elaborate effects of that solid waste on geotechnical properties of soil.
- To compare laboratory tests on leachate affected soil and healthy soil and bring out conclusions about the strength properties of soil.
- To increase the shear strength of MSW Leachate by stabilizing it with RHA.
- To understand behavior of RHA when it is subjected to use as soil stabilizer.

Conclusion

There are several studies conducted to understand the properties of synthetic leachate and how it reacts when certain amount of uncontaminated soil is added to it so that the strength parameters of the contaminated soil gets improved. Rice husk ash (RHA) can play a vital role in stabilizing the leachate affected soil. It will increase the shear strength of soil by entering into the voids and porous of the contaminated soil. So in this project it was seen that RHA can be added up to 50% in contaminated soil, and uncontaminated laterite soil and uncontaminated B.C soil can be added upto 30% to overcome the weakness of leachate affected soil. It was observed that the waste water generated from industries and households contains hazardous poisons.

Salient points that can be concluded are as below.

- Dumping of municipal solid waste at dump yards will increase the toxic substances in it.
- Laterite soil and B.C soil can be added up to leachate to increase its strength properties.
- Optimum moisture content and maximum dry density will be increased after blending leachate affected soil with uncontaminated soil.
- Liquid limit and plastic limit will be increased if MSW soil is blended with uncontaminated soil and RHA.
- CBR values vary in concentration of variation in percentage of soil and RHA.
- Blending with RHA will lead to increase in OMC and decrease in MDD.
- CBR increases with increasing in % of Rice husk ash.
- On the basis of this study it can be concluded that the addition of leachate to soil will results in bringing negative impact on geotechnical properties of soil.
- Proper care should be taken while dumping solid waste directly on to the land and composite liners should be provided before dumping.

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