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SECURED LANDFILLS FOR DISPOSAL OF MUNICIPAL SOLID WASTE

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Abstract—
A landfill is a facility which is designed for the safe disposal of solid wastes. The bottom liners and a top Cover, of the landfill are considered as the most critical components. Penetration of Leachate in to the soil is the major problem in landfills. For existing landfills the main factor affecting the quality of liners/covers is its permeability which should not be greater than 1.0×10^{-9} m/sec. Alternative materials which can be used as liners are compacted ball clay, vitrified ceramic tiles, limestone slabs which have permeability relatively less compared to compacted clay. The compacted ball clay in the form of tiles (green) had undergone heavy compaction which in turn reduces permeability and the thickness of the liners/covers. By reducing the thickness of liners more amount of municipal solid waste can be accommodated. Usage of alternative materials will reduce the overall thickness of liner system by about 40-50cm

Index Terms— Municipal solid waste, Leachate, Liner/Cover, Permeability, porosity, compacted Ball clay tiles (green), Amended soil, Ceramic tile

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INTRODUCTION

Solid waste may be defined as generation of undesirable substances which is left after they are used once. They cannot be reused directly by the society for its welfare because some of them may be hazardous for human health [1]. At present, the annual generation is approximately 1.6×10^9 ton in India [2]. Land filling has been the most common method of solid waste disposal [3].

The central problem in landfill disposal is leachate control and thickness of liners and covers. A surface seal landfill design is recommended for maintaining the dry state of solid hazardous wastes and for controlling leachate [5]. Bottom liner and top cover plays very important role in reducing the leachate quantity [6].

PRESENT PRACTICES OF SOLID WASTE DISPOSAL

Various practices are Non-engineered disposal which means open dumping. Land filling is disposal of waste with different liners and finally with earth cover. Incineration is burning of solid waste. Pyrolysis is a form of incineration that chemically decomposes organic materials at high temperature in the absence of oxygen. Vermicomposting in which earthworms feed on the organic matter present in the solid waste and convert into casting. Composting is biodegradation of organic matter. Reuse & Recycling of waste materials. Energy generation by subjected decomposing organic material to digestion [1].

ALTERNATIVE MATERIALS FOR LINER AND COVER

In recent years, geo membrane and geo synthetic clay liners have been used to improve the performance of liner. But these liners are vulnerable to accidental puncture and create a potential problem with interface shear between their surfaces. Hence composite clay liners are preferred.

The different alternative possible materials are compacted ball clay, limestone slabs, vitrified ceramic tiles, and compressed ball clay blocks.

METHODOLOGY

A. Sample collection

Sample of Dwaraka Tirumala ball clay occurring near Bhimadolu, West Godavari Dist, A.P, India is collected from M/S Vennar ceramic Industries Ltd., Perikigudem, near Gudiwada Krishna Dist, A.P, India

B. Preparation of granulated ball clay powder

Ball clay ground in pot mill with 40% of water, for 3 minutes and the slurry is transferred into a Galvanized Iron (GI) tray. This slip is dried in a lab oven and the dried flakes are ground. 6% of water is sprinkled on the powder, mixed and made to pass through 20 IS mesh to prepare granulated powder. This powder is tested for bulk density using a density bottle and the results are given in table-1.

C. Preparation of ball clay tiles (green)

Granulated ball clay powder is pressed in a lab scale hydraulic press at a pressure of 100kg/cm^2 to obtain the green tile. These tiles are subjected for testing of flexural strength, dry shrinkage, bulk density and the results are given in table – 2.

D. Testing of vitrified ceramic tiles

Samples of vitrified tiles of 300x300x10mm are collected from the market and subjected to testing of flexural strength, water absorption, chemical resistance in accordance with IS 15622. The results are tabulated and presented in table – 3. Further it is tested for reactivity with lechate by keeping it in solid waste for 2 months and comparing with fresh sample.

E. Testing of Lime Stone

Lime stone is kept in solid waste for 2 months in order to test its reactivity with the lechate. The lime stone slab is tested for flexural strength and water absorption. Test results are given in the table-4.

PROPOSED DESIGN OF LINER

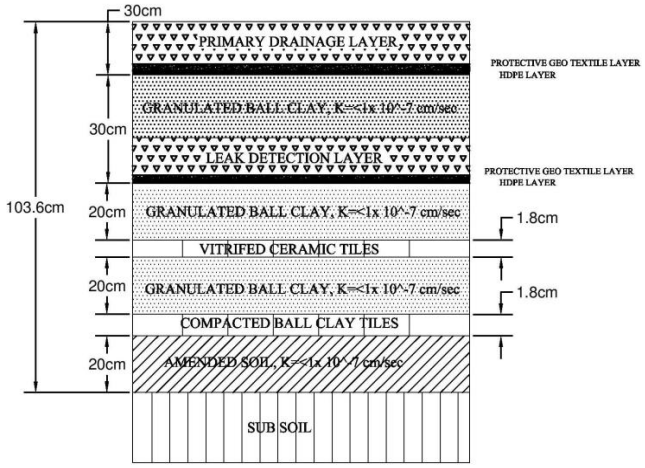
Based on the study of various liners of existing landfill design is found to have an overall thickness is about 150cm.

A. Lining of Base and Sides

Over the sub soil amended soil is placed and compacted of thickness 20cm at a permeability of 1x10^{-7}cm/sec over that compacted ball clay blocks are placed of thickness 2cm after that granulated ball clay powder of thickness 20cm is placed then ball clay powder is compacted. Vitrified ceramic tiles are arranged above the compacted granulated ball clay powder of thickness 1.8cm over that granulated ball clay powder is placed and compacted to the thickness of 20cm and geo membrane is provided on it.

Secondary Leachate collection layer of thickness 30cm is provided. A secondary composite liner comprising of HDPE geo membrane of thick 0.15cm is provided above the drainage layer granulated ball clay is placed to the compacted thickness of 20cm.

Primary a Leachate collection layer of thickness 30cm is placed. A primary composite liner comprising of a HDPE geo membrane of thick 0.15cm is provided. Hereby considering the thickness of each layer the overall thickness for the proposed liner will be 103cm.



Liner design fig.1

B. Cover System

Above the solid waste operational (transitional) layer of 30cm thick is placed a compacted amended soil of 40cm thick is laid above it. HDPE geo membrane of 0.15cm thick is placed beneath the drainage layer of 30cm. The top of the cover is enclosed with a vegetative layer of 60cm. Granulated spray powder of ball clay is placed as a daily cover over the cover system. So that gasses that produced in the landfill may not escape

This design can be used for both hazardous and municipal solid waste purpose.

RESULTS AND DISCUSSIONS

A. Granulated ball clay powder

Table-1

S.no	Parameter	Results
1	Sieve size	
	20mesh	0.2-0.8% retained
	44mesh	3.4-6.8% retained
	52mesh	8.8-12.9%retained
	60mesh	18.2-39.6%retained
	80mesh	29.6-32.4%retained
	120mesh	3.2-9.1% retained
	-120 mesh	-0.5% retained
2	bulk density	992 gm/lit

B. Compressed Ball Clay Tile (green)

Table-2

S.no	Parameter	Results
1	Thickness	9.6mm
2	Flexural Strength	6.9kg/cm2
3	Bulk Density	1.89g/cc
4	Dry Shrinkage	1.02%
5	Moisture Content	5.00%
6	Porosity	< 0.5%

Compressed Ball Clay Blocks fig.2

Hydraulic press fig.3

C. Vitrified Ceramic Tile

Table-3

S.no	Parameter	Results
1	Flexural Strength	462.4kg/cm2
2	Water Absorption	0.01%
3	Size	50x100mm
4	Chemical Resistance	Cannot resist HF acid
5	Thermal Expansion	7x10-6 cm

D. Lime Stone Slab

Table-4

S.no	Parameter	Results
1	Water Absorption	5.80%
2	Flexural Strength	268kg/cm2

CONCLUSION

As the experimental results shows that porosity values for compacted ball clay tile is < 0.5% and porosity for ceramic tile is 0.01% the porosity value is less when compared to the compacted clay. As the porosity is less permeability is also less. Hence the penetration of lechate into overlaying layers can be controlled.

From the proposed design it is clearly shown that the thickness of the entire lining system is reduced by 40-50cm thickness. So that more amount of waste can be accommodated in the landfills when compared to the existing landfills

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REFERENCES

[1] R. Rajput, G.Prasad and A.K.Chopra, (2009) Scenario of solid waste management in present Indian context, Caspian J. Env. Sci. Vol. 7 No.1 pp. 45~53©Copyright by The University of Guilan, Printed in I.R. Iran

[2] Sherien Elagroudy, Tamer Elkady, Fikry Ghobrial, (2009) Comparative Cost Benefit Analysis of Different Solid Waste Management Scenarios in Basrah, Iraq , Journal of Environmental Protection, 2, 555-563

[3] K. Hadjibiros, D. Dermatas and C.S Laspidou, (2011) Municipal solid waste management and landfill site selection in Greece: irrationality versus efficiency**,** Global NEST Journal, Vol 13, No 2, pp 150-161, Global NEST (GREECE)

[4] Mangizvo V. Remigios,(2010), An Overview of the management practices at solid waste disposal sites in African cities and towns, Journal of Sustainable Development in Africa (Volume 12, No.7) ISSN: 1520-5509,Clarion University of Pennsylvania, Clarion, Pennsylvania

[5] Karen M. Slimak, (1978), Landfill Disposal Systems, Environmental Health Perspectives

Vol. 27, pp. 309-316

[6] Nilanthi J.G.J. Bandara, J. Patrick A. Hettiaratchi, (2010). Environmental impacts with waste disposal practices in a suburban municipality in Sri Lanka, International Journal. Environment and Waste Management, Vol. 6, Nos. 1/2, 2010

[7] Sani Yahaya, Christopher Ilori,(2010) Land Fill Site Selection for Municipal Solid Waste Management using Geographic Information System and Multi criteria Evaluation**,** American Journal of Scientific Research ISSN 1450-223X Issue 10 (2010), pp. 34-49 © Euro Journals Publishing, Inc.

[8] Mufeed Sharholy, Kafeel Ahmad, Gauhar Mahmood, R.C. Trivedi, (2007). Municipal solid waste management in Indian cities, Waste Management 28 (2008) 459–467

[9] Shiou-San Kuo1; Karishma Desai2; and Lymari Rivera, (2005). Design Method for Municipal Solid Waste Landfill Liner System Subjected to Sinkhole Cavity under Landfill Site, DOI: 10.1061/(ASCE)1090-025X(2005)9:4(281)

[10] Adriana Soares de Schueler1, Claudio Fernando Mahler,(2011),Classification Method for Urban Solid Waste Disposal Sites, Journal of Environmental Protection, 2, 473-481

[11] R.M.Jones, E.J.Murray, D.W.Rix, R.D.Humphery, (1995). Selection of clays, waste disposal by landfill-GREEN'93 SARSBY,

[12] M. A. Warith, (2003). SOLID WASTE MANAGEMENT: NEW TRENDS IN LANDFILL DESIGN**,** Emirates Journal for Engineering Research, 8 (1), 61-70 (2003)

[13] Richard k. Brown, WYO-BEN, INC., USA Field construction and quality control practices for high quality compacted soil membranes

[14] Criteria for hazardous waste landfill (HASWAMS/17/2000-01), CPCB (2001)