International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 4 Issue 02, February-2015

Engineering Landfill Design for Municipal Solid Waste Managememt, Bangalore

Dr. D P Nagarajappa
Professor,
Department of Civil Engineering,
University BDT College of Engineering , Davangere,
Karnataka

Rashmi B N,
Department of Civil Engineering,
University BDT college of Engineering, Davangere,
Karanataka

***Abstract* - The present Study involves the Municipal solid waste management and landfill design at Bangalore. Physically it contains the same material as are found in useful products, and differs from useful production by its lack of value. A basic approach to deal with waste, therefore, is to restore value to it. The term landfill is used to describe a unit operation for final disposal of Municipal Solid Waste on land, designed and constructed with the objective of minimum impact to the environment. This term encompasses other terms such as secured landfill and engineered landfills which are also sometimes applied to municipal solid waste (MSW) disposal units. The study mainly focused on the landfill liner design from which the groundwater contamination can be reduced from the leachate.**

INTRODUCTION

Bangalore, the capital of Karnataka State is one of India's fast developing city with an average annual growth rate of 3.25 % and population of 8.4 Million (census 2011)and area of 800 sq km. Today, it is India's one of the largest city, the momentum of its industrial and commercial growth unequalled in the country. The current practice of solid waste management at BBMP is, about 70% of the MSW (Municipal Solid waste) activity starting from primary collection to disposal has been outsourced & 30% is managed by BBMP. While the increase in population has been tremendous, there has been increase in the generation of Solid waste. Bangalore generates 4,000 tons of waste every day from households and commercial establishments. Around 70% of this waste is organic. The balance is accounted for inorganic and hazardous waste. The current practice of primary collection (door to door) as well as the secondary collection and transportation is in place. The waste is disposed off in the dump / landfill sites at the end.(Source : BBMP 2013

Waste generation

Municipal Solid Waste (MSW) is the waste generated by households, commercial activities related to day-to-day human activities. As the waste that general public have contact with, management of MSW, has a high political profile. Additionally, household waste is, by nature, one of the largest sources of waste to manage effectively. It consists of a diverge range of materials (glass, metal, paper, plastic, textile, organic matter) totally mixed together, with relatively small amounts of each. MSW composition is also variable, both geographically and seasonally, from country to country, city to city and across the country. Broadly MSW is generated from the following sources:

- Households
- Markets
- Hotels, Restaurants, Mess, Lodges, and other commercial food establishments
- Function halls, Cinema halls and other similar locations
- Other commercial and bulk generation sources like hospitals, clinics…
- Street Sweepings
- Street Bins
- Construction Debris
- Other similar establishments.

Landfillable waste

Land filling shall be restricted to non-biodegradable, inert waste and other waste that are not suitable either for recycling or for biological processing. Land filling shall also be carried out for residues of waste processing facilities as well as pre-processing rejects from waste processing facilities. Land filling of mixed waste shall be avoided unless the same is found unsuitable for waste processing. Landfilling will be done for the following types of waste:

(i) Comingled waste (mixed waste) not found suitable for waste processing;

(ii) Pre-processing and post-processing rejects from waste processing sites;

(iii) Non-hazardous waste not being processed or recycled.

Essential components

The seven essential components of a MSW landfill are:

(a) A liner system at the base and sides of the landfill which prevents migration of leachate or gas to the surrounding soil.

(b) A leachate collection and control facility which collects and extracts leachate from within and from the base of the landfill and then treats the leachate.
(c) A gas collection and control facility (optional for small landfills) which collects and extracts gas from within and from the top of the landfill and then treats it or uses it for energy recovery.

(d) A final cover system at the top of the landfill which enhances surface drainage, prevents infiltrating water and supports surface vegetation.

(e) A surface water drainage system which collects and removes all surface runoff from the landfill site.

(f) An environmental monitoring system which periodically collects and analyses air, surface water, soil-gas and ground water samples around the landfill site..

Table 1 : Physical characteristics of Bangalore Municipal Solid Waste(Source : BBMP)

Organic waste (%)	60
Dust (%)	5
Paper (%)	12
Plastic (%)	14
Glass (%)	4
Metal (%)	1
Bio Medical Waste	1
Card Board	1
Rubber	1
Miscellaneous (%)	1

Mavallipura site features

Table 1: Site Features

Features	Details
Latitude	13°07'16.16"
Longitude	77°32'17.97"
Mean elevation of the site	Ranging from 51.38 m to 38.65 m above MSL
Land area	45acres
Land use	Barren
Nearest highway	7.5 km away from the National highway No. 7 connecting Mangalore to Chennai
Access Road	Approach road to the site is well developed
Water bodies and dams	Hessargatta water tank – 5.5 km
Reserve forests, Ecological zones, Monuments, railway station, major settlement	None within 10 km
Climatic Conditions	Summer-temperature ranges from 28 to 36c Winter – temperature ranges
Socioeconomic	Agriculture based
Major crops	Ragi, Maize,jowar,
Minor settlement	Mahvallipura village with 3 km
Airport	Bangalore airport more than30km Deccan aviation center at 8 km
Reserve forests	None within 10 Km

Results obtained from the ground water analysis

Table 3 : Ground water test result

Parameters	Units	Limits as Per IS:10500-1991(Desirable)	Sample
pH	-	6.5-8.5	7.6
EC	µmhos/cm	1500	650
Chlorides	as Cl mg/l	250	80
Sulphates	as SO_4 mg/l	200	141.5
Total Hardness	mg/l as $CaCO_3$	300	250.0
Calcium hardness	mg/l as $CaCO_3$	------	220.0
Magnesium Hardness	mg/l as $CaCO_3$	------	30.0
TDS	mg/lt	300	360
Calcium	mg/l as Ca	75	17.6
Magnesium	mg/l as Mg	30	7.32
Nitrates	as NO_3 mg/l	45	22.0
Iron	mg/l	0.3	0.2
DO	mg/l	6	3

From the present study of the assessment of ground water in and around Municipal solid waste dumping site of Mavallipura Bangalore, it is found that some of the parameters like Total Dissolved Solid (TDS), Total Hardness (TH), Calcium, Magnesium and are above the acceptable limits of Indian Standard for drinking water (BIS-10500:1991). The higher concentration of TDS in the water samples of bore well shows the penetration of landfill leachate has occurred to the subsurface water. Hence the liner used acts as a shield to protect the ground water from getting contaminated from the leachate.

Fig 1: Satellite imagery of landfill site

Design considerations

Landfill capacity	: 1000MTPD
Landfill life	: 10 years
Depth of Landfill	: 4m

Liner used

The clay liner thickness at base landfill is 1m. Permeability of clay liner is < 1x10-9 cm/s. The liner placed in layers not exceeding 300mm and then compacted to the desired permeability and raised to a total thickness of 1m. The clay liner is compacted at +4% wet OMC. The top of the clay liner, as well as the base of the landfill is effectively graded to attain a clear slope of 2% towards the leachate collection sump.

Leachate Collection System

The leachate collection pipes are embedded in a drainage media for effective collection of leachate. The drainage media shall be also flow into the leachate collection sump.

A geo-textile barrier is placed over the drainage media to ensure only liquid percolation into the drainage and thus also ensures that the drainage media does not get choked.

Landfill Gas Collection System

Daily and intermittent covers of soil shall be placed over the wastes on a regular basis to ensure that odor generation is minimized. This also acts as a barrier thus providing for fire protection and effective movement of waste dumping trucks into the landfill. It further minimizes the bird menace by way of minimizing the exposure of waste. Before capping the landfill gas vents and gas collection system shall be fitted to ensure that any gas generated in the landfill shall be effectively collected. The gas quantities are presumed to be small and hence they would be destroyed in the flare stack. However, if excess gas is collected it shall be collected and utilized for energy recovery.

Waste Processing

Waste processing and transformation Solid waste processing reduces the amount of material requiring disposal and, in some cases produces a useful product. Examples of solid waste processing technologies include material recovery facilities, where recyclable materials are removed and/or sorted; composting facilities where organics in solid waste undergo controlled decomposition; and waste-to-energy facilities where waste becomes energy for electricity.

Composting

Composting is a natural micro-biological process where bacteria break down the organic fraction of the MSW stream under controlled condition to produce a pathogen-free material called “compost” that can be used for potting soil, Soil amendments (for example, to lighten and improve the soil structure of clay soils), and mulch. The microbes, fungi, and macro-organisms materials is placed into one or more piles (windows) and the natural microbial action will cause the pile to heat up to 65-800C, Killing most pathogens and weed seeds. A properly designed compost heap will reach 700C within 6 to 10 days, and slowly cool off off back to ambient temperatures as the biological decomposition is completed. Systematic turning of the material , which mixes the different components and aerates the mixture , generally accelerates the process of breaking down the organic fraction , and a proper carbon/nitrogen balances(carbon to nitrogen or C/N ratio of 20:1) in the feedstock insures complete and rapid composting . The composting process takes from 17 to 180 days.

Composting Methodology

The methodology adopted shall be as follows:

- Waste is delivered in windrow.
- Inoculum is sprayed on the waste in
- Water is sprayed on the waste.
- Each windrow is turned on 6th and 11th days outside to the centre to provide aeration. This also destroys insect’s larvae.
- Turning is carried out by using front end loaders etc.
- On 16th day windrow is broken down.
- It is then passed through a rotary screen of about 25mm square mesh to remove oversize contrary material.
- The oversized material is sent to landfill for disposal.
- Screened compost is sent for packaging.

CONCLUSIONS

1. Landfilling for solid waste has the best method for disposing the MSW, as the cost is less compared to the other methods like incineration.
2. Composting method for waste processing has found to be the superlative as it is environmental friendly.
3. The landfill liner used protects the groundwater from contamination, as it does not percolates in to the soil.
4. As the Leachate is collected separately and treated, the effect of leachate to ground water is less.
5. The gas produced from the MSW is collected which minimizes the pollution that can be caused from the landfill gas.

6. Study and design of different Solid waste disposal systems at the proposed site suggests that landfill gases released can be recovered and can be used as an alternatively source of energy.

REFERENCES

1. APHA (1998), "Standard methods for examination of water and wastewater", 19th edition American Public Health Association, Water Environment Federation Publication, Washington, DC.
2. A. Kansal(2002), "Solid waste management strategies for India", Indian
Journal of Environmental Protection, vol . 22(4), pp. 444–448.
3. Barijinder Bhalla, M S Saina and Jha M K(2012), "Characterization of Leachate from Municipal Solid Waste Landfilling sites of Ludhiana, India: A Comparative Study", International Journal of Energy Research and Application , Vol 2,pp732-745.
4. Barijinder Bhalla, M S Saina and Jha M K(2014), "Assessment of Municipal Solid waste Landfill Leachate Treatment Efficiency by Leachate pollution Index", International Journal of Innovative Research in Science Engineering and Technology, vol 3,pp8847-8848.
5. Bundela P S, Gautam S P, Pandey A K, Awasthi M K and Sarsaiya S(2010), "Municipal Solid waste Management in Indian Cities – A review", International Journal of Environmental Sciences, vol.1,No.4,pp 591
6. CPCB(2000). Status of Municipal Solid waste Generation, Collection,Treatment and Disposal in Class I Cities, Series:ADSORBS/31/1999–2000.
7. Dhokhikah.Y, and Trihadinigrum.Y(2012), "Solid waste Management in Asian Developing Countries : Challenges and Opportunities", Applied Environmental and Biological Science , vol.2(7),pp.329-335.
8. George Tchobanoglous and Frank Krieth,"Handbook of Solid waste Management" Second edition, pp
9. Manimekalai B and Vijaylakshmi P(2012) "Analysis of leachate contamination potential of a municipal landfill using leachate pollution index", Journal of Environmental Science , vol 2, pp16-39
10. Manju Rawat and A L Ramanathan(2011) "Assessment of methane flux from Municipal Solid waste (MSW) Landfill areas of Delhi, India", Journal of Environmental protection ,pp 399-407
11. Matsufuji.Y.,Tanaka.A.andHanashima.M(2004),"Biodegradatio n process of Municipal solid waste by Semi-aerobic landfill type" ,Landfill Research symposium, pp1-2