Design of MSW landfill with reference to PCMC area requirements

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Abstract : In Pimpri Chichwad Municipal Corporation area the most accepted disposal system for municipal solid waste(MSW) is open dumping of waste in the landfill which now-a-days has low rates of stabilization. The objective of this study is to develop design criteria for engineered sanitary landfills which lead to reduction in stabilization times of MSW .In this project we are going to convert open dump landfill into an engineered landfill. In PCMC the daily waste generation is 800 tons. It consist of biodegradable ,non biodegradable ,plastic, industrial, household, sanitary waste. First we separate the waste and then process it .We are going to lay plastic sheets at the bottom of the landfill. A system of pipes will be installed to collect the leachate .The processed waste will be mix with soil and layers of that will be laid in the landfill. After the landfill is filled with layers its completely covered with a thick layer of soil .In this way the engineered landfill is designed. We are going to conduct various test on soil such as sieve analysis, consistency limits, compaction test, shear test , permeability test , consolidation test etc. The data collected from this test will give us geotechnical properties of the waste and will be helped in designing the engineered landfill.

Key Words: biodegradable,nonbiodegradable,MSW

1.INTRODUCTION

1.1 India's Situation

During the previous two-and-a-half decades, India's economic growth has been among the most rapid in the world with experiencing tremendous growth in urban areas. This increased urbanization associated with growing economy has posed a significance stress on the environment. The scenario in India is also alarming as MSW is expected to increase from 85 million tons in 2011 to 300 million tons by 2047(Ministry of Urban Development, 2000). Studies have shown that per capita waste generation in India is increasing by about 1.3% per year. The urban population is growing at the rate ranging between 3 to 3.5% per annum; which will lead to increase in overall quantity of solid waste by about 5% (Ministry of Finance, 2009).

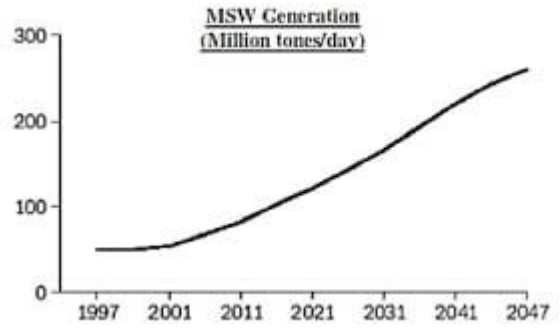


Figure1- Waste Generation Rate in India (MoF,2009)

1.2 PCMC Situation

The twin city (Pimpri Chichwad) is governed by the Pimpri Chichwad Municipal Corporation (PCMC). PCMC and Pune, when viewed as a unified geographical unit, make up one of India's largest industrial areas .

Accordingly, the population reached to 17.29 lakh in 2018 and estimated to reach 21.50 lakhs in 2021 and over 29 lakhs in 2031(Environmental Status Report 17-18). The population of Pimpri Chichwad in the last two decades grew at an annual average rate of over 7% against the national average of 2.1% at site average of about 3.3% PCMC area is generating approximately 800-900 Metric Tons per Day (MTD) solid waste as given in ESR (2017-2018).

1.3 Municipal Solid Waste

MSW defined to include refuse from households, hazardous solid waste from industrial and commercial establishments, refuse form institutions, market waste, yard waste and street sweeping (World Bank, 1994). The nature of MSW being variable in both quantity and characteristics makes Municipal Solid Waste Management (MSWM) a challenging task. The management practice has to address generation, sorting, collection, transportation and processing.

Table 1: Overview of SW (ESR- 2017-2018)

Population of PCMC area (2018)	17.29 lakh
Area of dumping site	81 Acre
Total waste generation	850 MTD
Per capita generation	
Total waste collection	500 MTD
Waste dumped	400 MTD
Distance of dumping ground from city	20 KMS
No. of vehicles used for disposal of solid waste to facilities	Primary: 336 Secondary : 89

Waste generation is found to directly proportional to the level of affluence or income and likely to increase at more rates for lower income and lower middle income group as shown by World Bank.

2. Literature Review

Various reports of NEERI (National Environmental Engineering Research Institute), CPCB (Central Pollution Control Board), ISWA (Indian Solid Waste Act), JNNURM (Jawaharlal Nehru National Urban Renewal Mission), ESR(Environmental Status Report),World Bank, NGOs(Non-Governmental Organizations) to understand practice of waste management across the world and within India, economics of the sector, its impact on livelihoods. Process of engineered landfill designing, role of waste management sector , and the entire process of waste collection to engineered disposal.

2.1 Generation

Waste is generated from various sources as residential, commercial, institutional buildings and municipal services as street sweepings, recreational areas (Environmental Information System, 2018). The main components are organic i.e. food and kitchen waste; recyclables as plastic, paper, cardboard etc., composites as rags, toys; inert as soil, construction and demolition debris and domestic hazardous waste as tube lights, spray, batteries (ENVIS 2018). The percentage composition of each type of waste varies according to the type of generator, their income level, standard of living i.e. food habits, degree of commercial activities and seasons and availability of resources.

2.2 Collection

Common practice of collection in India is to collect waste from source to common point and then to vehicle. Collection happens at two levels and by two different agencies in most cases: (a) primary collection from source to common collection point and (b) secondary collection from collection point to collection vehicle (MoUD, 2000) (UNHabitat, 2010). Collection efficiency of MSW depends on generation rate, population growth, vehicle capacity, vehicle availability. Collection efficiency is calculated using waste collected per day against waste generation per day.

2.3 Transportation

The functional element of transportation involves two steps (MoUD, 2000), one is the transfer of wastes from the smaller collection vehicle to the larger transport equipment and other is his subsequent transport of the wastes, usually over long distances, to a processing or disposal site. The transfer usually takes place at a transfer station. Various types of vehicles such as compactor trucks, dumpers, Small Closed Vehicles (SCVs) are used mostly for transportation (UNHabitat, 2010). Waste is transported from the collection points to the landfill site every day.

2.4 Processing

Waste processing leads to reduction in the volume, weight, size or toxicity of waste without resource recovery and it can be done by variety of mechanical, thermal or chemical techniques. The waste is allowed to dry for 7 days where they sprinkle odofresh, bioclean and sargo chemicals . Afterwards it is passed through static loader where waste is compressed and volume reduction occurs and goes through conveyor belt. Then passes through trommel (75MM, rotary screen) which is a mechanical screening machine used to separate solid waste and again passed through 35MM trommel. Then segregation is done in two parts, one for making fuel i.e RDF(Refuse- derived fuel) is a fuel produced from MSW and second for windrow section used to make fertilizers. Coconuts are separated to make cocopit and its used for making gunny bags. The plastic is removed from the waste and used to make Plastic pavements and fuel(diesel). The waste is kept in windrow for 40 days and quick arabic powder is spread over it. Then for 5-6 days turning is done. After 35mm trommel it is passed through 16mm trommel and oversized and undersized parts are separated. Then temperature cooling below 80 degree celcius for 20 days is carried out and if needed water is sprayed.Then it is again passed through 4mm trommel and finer compost is achieved.

2.5 Disposal

The waste is collected from all parts of the city and brought at the Moshi Dumping Ground. The waste is separated according to various factors and processing is done accordingly. The processing is shown below:

Table : Process done on waste at Moshi Dumping

Sr.no.	Projects	Capacity (MTD)	Ongoing process (MTD)
1	Mechanical composting	500	435-450
2	Vermi composting	30	12-15 (vegetable market) 15-18 (S.T.P sludge)
3	Fuel from Plastic	5	1.5 to 2
4	Capping	11 acre	4 lakh meter cube

Source: Health and Environment Department, PCMC

Mechanical Composting: Decomposition and stabilization of organic matter under controlled condition is known as composting. Mechanical Composting in Moshi deals with 435 MTD .

Vermi composting: It is a special process in Moshi Dumping Ground. The composting is done with the help of earthworms. This project is managed on PPP guidelines under Pimpri Chichwad Municipal Corporation JnNURM. In the total area of 2.2 Hectors , 30 MTD vermicompost is created. In recent scenario, 12 to 15 ton waste from vegetable market is the main source for earthworms to create the vermi compost. In the same project 15-18 ton STP sludge is also processed and compost is produced.

Fuel from plastic: The capacity to produce fuel from plastic waste per day is 5MTD and presently 1.5 to 2 MTD plastic is processed per day. The biproducts are LPG and Diesel which are used in industries.

Sanitary landfill: Landfill is the disposal of waste material by burying it especially as a method of filling it and reclaiming excavated pits. The landfill is designed to dispose of non-hazardous solid waste. All disposable areas are constructed with a composite liner system and leachate collection system. Landfill is the oldest form of disposal and also most economic process. The biproduct is leachate which can be furthur used to make fuel.

Capping: The PCMC has dumped 4 lakh meter cube of waste before 20-22 years at an area of 22 acres and capping is done on it in the most scientific way.

3. Methodology

3.1 Data Collection

The basic information about waste generation, collection and then its disposal was gathered from World Wide Web. Case study of the previous published papers related to the topic gave us the technical information and a broad mindset of the required area. Records maintained by the Health and Environment Department of PCMC were accessed from their official website and basic information about Moshi Dumping Ground was recovered.

3.2 Situation analysis of study area

The Moshi Dumping Ground is located at 20 kms from the city. The BVG (Bharat Vikas Group) runs the Moshi dumping ground under PCMC. The site is dvided into four major sectors. They are as follows:

- Mechanical composting with a capacity of 500MTD and daily processes 450 to 500 MTD
- Vermi composting with a capacity of 30MTD
- Fuel generation from plastic with a capacity of 5MTD
- Capping over 11 acres

3.3 Study of present landfill design on the site

Firstly, the area is dug till 1.5 meters. Then its covered with a layer of soil to make the base even without any bumps. After that it is covered with HDPE (High Density Polyethylene) which prevents the leachate generated from penetrating into the ground. Also pipelines are provided for leachate collection which carries the polluted liquid to collection tank and then further processing. Then aggregate layer is spread on the area for percolation. Then Composite liner which is made of geomembrane along with geosynthetic clay liner is layed. They are better at reducing leachate migration into the subsoil. Now after this process, layers of waste and soil are placed alternatively according to design specifications. The waste layer is 1.5 meters thick and soil layer is 4 to 6 inches thick. Vertical

ducts are provided for the removal of methane gas which is generated due to decomposition of the waste under landfill. If the ducts are not provided then there can be a blast due to methane gas.

3.4 MSW Sampling and collection

Three types of different samples were collected from the soil- Fresh sample, Sample after 40 days and 40mm trommel sample.

3.5 Testing

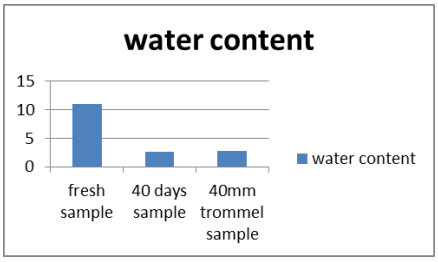
Following test were conducted on the collected samples.

1. Water Content Test

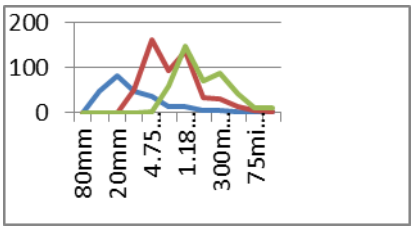
Water content of fresh sample is 10.9375

Water content of 40 days sample is 2.667

Water Content of 40 mm trommel is 2.8571



2. Sieve Analysis Test



3. Segregation test

Type of waste	Percentage
Organic Waste	57%
Plastic and Polythene	17%
Paper and Cardboard	14%
Glass and Ceramic	11%
Others	1%

4.CONCLUSIONS

We have discussed all the major geotechnical properties of the soil as well as the waste which is going to be dumped in the landfill.The major properties of soil, the details about the surrounding area like population, amount of waste generation is calculated in a precise manner. After all this detailed study we have designed a landfill considering the current situation and improvising it. We have also given effective measures for effective landfill operations.

The waste has several components which have potential to be reduced reused and recycle. This potential is underutilized due to lack of awareness among generations and lack of sense of ownership and responsibility. 75% of total waste can be reduced from going to landfill by practicing 3Rs.This will not only reduce pollution but benefit in a many more ways.

Due to increase in population, we have to do population forecasting and recycle technologies to minimize the waste.

REFERENCES

1. Al-Youssifi A and Pohland FG. Modeling of Leachate and Gas Generation during Accelerated Biodegradation at Controlled Landfills. Porc. 31st Annual Solid Waste Exposition of the SWAN, San Jose, CA. 1993.

2.Barlaz, M, Ham, R. Gas Production Parameters in Sanitary Landfill. Waste Management

Research. pp. 27-39. 1987.

3.Barlaz, MA, Ham, RK and Schaefer, DM.

Methane Production from Municipal Refuse: A Review of Enhancement Techniques and

Microbial Dynamics, Critical Rev., 557p. 1990.

4.Carven, W, Vogel. K Field Investigation of Landfill Leachate Collection System. Research project by Florida Center for Solid and Hazardous Waste Management. pp.1-9. 1999.

5.Christensen, T, Kjeldsen, P Basic Biochemical Processes in Landfills. Academic Press Ltd., Toronto. pp. 29-49. 1989.

6.Hudgins, M, The Development and Evolution of In-Situ composing of Landfill Waste. Conference on Solid Waste Technology and Management, Philadelphia. 1999.

7.Environmental Status Report 2017 by PCMC

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