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Pre Monsoon Analysis of Solid Waste Characteristics as Per Depth at Phursungi Dumping Yard in Pune Region

Chetan G. More[1], Sagar M. Gawande[2]

[1]Department of Civil Engineering, Anantrao Pawar College of Engineering &Research, Parvati Ramana, Pune, Maharashtra, India
[2]Department of Civil Engineering, Anantrao Pawar College of Engineering & Research, Parvati Ramana, Pune, Maharashtra, India

Abstract: ***The by-product of drastic development and transformation in behaviour of human action is creating a corpus of solid waste which is creating unease position in world and in India. Per capita resource consumption in urban areas of India is more related to rural area of India which is also producing the waste in the same proportion. In India, Pune is a cosmopolitan city in Maharashtra state showing typical urban population which produces about 1500 – 1600 MT of solid waste per day. Pune Municipal Corporation disposes the municipal solid waste in Phursungi dumping yard depot. The residents of Phursungi and Urli villages, who have been agitating for the closure of garbage depot, are dissatisfied. It has been more than a decade since they began agitating, but no concrete action has been taken so far. On the contrary, the stink and pollutants emitting from the depot have left them more inclined to health issues and to increase the efficiency of dumping yard it is very important to understand the characteristics of solid waste. Previously the characteristics of solid waste of Pune have been studied but in this paper it has been studied as respect to the horizontal as well as vertical plane up to the depth of 6 feet by using the designed sampler.***

Keywords: Phursungi dumping yard, Solid waste management, Characteristics, Moisture Content, Undisturbed density, Temperature

1. Introduction

Indian economic advancement of society is leading to more complex solid waste because of use of plastic, synthetics and more use of packaging material. Advancement in technologies and the rise in per capita waste produce exotic waste which is making heaps of garbage is challenging situation for engineers to find a better solid waste disposal solution and for that study of characteristics of solid waste is essential. [1]

Yearly solid waste generated by around 300 million people living in rural part of India sums up to 38 million tons. India produces daily about 1,00,000 MT of Municipal solid waste, these numbers tend to increase drastically with increasing population, urbanization and industrialization. Maximum expenditure by Local bodies of urban areas is involved for street sweeping of waste collection and transportation. And tiny amount, around 5% is spent for final disposal which is insufficient and main cause of issues like odour and health related complications. [2]

Pune city is well-known on the world map because of its scenic beauty and rich natural resources as well as its educational institutions. "Phursungi" area is one of the most beautiful areas on Pune's periphery in which hundred tons of solid waste is discarded every day. All of this has accumulated in the last one decade creating huge amount of garbage. The city generates about 1500 to 1600 MT of waste per day, which is significant amount and it is going to increase with the population in the upcoming years so it is prerequisite of time for ground-breaking way of municipal solid waste disposal practice and as every city waste is distinctive in its own way there is always a need of study of characteristics of solid waste because there is no 'one size fits all' rather it is 'continues learning and improving' the system .[3][4]

In the previous paper the post monsoon characteristics of solid waste of Pune have been studied with respect to vertical plane but in this paper pre monsoon analysis study have been done with respect to the horizontal as well as vertical plane up to the depth of 6 feet by using the designed sampler.

2. Literature Review

Sr No.	Title	Year of Publication	Remarks	
			Composition of Solid Waste	Percentage (%)
1	Existing Situation of Solid Waste Management in Pune City, India by Mane T.T. and Hingane Hemalata N.	2012	Organic Waste	70
			Paper	8
			Plastic	7
			Metal	4
			Glass	6
			Miscellaneous	5
2	Extract from the report "Strategic Action Plan for Integrated Solid Waste Management Plan,Pune (Volume I)"	2006	Organic Waste	65
			Paper	8
			Plastic, Rubber, Leather & Synthetic	7
			Metal	6
			Glass	4
			Inert material	10
3	Revised city development plan for Pune - 2041, Maharashtra, under	2013	Organic Waste	33

	JNNURM (Report by PMC)		Paper	6
			Plastic	5
			Metal	3
			Glass	5
			Inert material	25
			Leather/ Rubber	1
			Miscellaneous	22
4	Integrated solid waste management (Energy revolution from municipal solid waste) - Report prepared by Solid Waste Management department of PMC. (http://opendata.punecorporation.org/Citizen/CitizenDatasets)	2016	Organic Waste	31
			Paper	6
			Plastic	9
			Metal	3
			Glass	5
			Inert material	23
			Leather/ Rubber	1
			Miscellaneous	22
5	Solid Waste Management in PCMC (3R"s Principle) By Niraj Burge & Sunil Gangurde. (source: Pimpri Chinchwad Municipal Corporation, Environmental Status Report 2012-13)	2015	Food waste	62.9
			Garden waste	18.65
			Paper	1.85
			Plastic & Rubber	1.23
			Glass	0.001
			Metal	0.01
			Wood	0.04
			Miscellaneous (textile, dirt, bricks, stones)	15.33

Figure 1: (Clockwise Direction): a) Collecting Sample b) Basic examination of sample c) Designed Sampler

3. Methodology

The Primary data is obtained from the site Phursungi dumping yard and Pune Municipal Corporation and correlated with the present investigation. The research work includes the efforts for waste characterization at various depths. Initially samples have been collected at various depths (0-2), (2-4), (4-6) feet with help of specially designed sampler (Cylindrical in shape) and the data analysis and reporting is done on the bases of data obtained by investigation.

4. Analysis of Solid Waste

The pre monsoon analysis of solid waste samples have been collected in the month of March – April 2017 from various points of Phursungi dumping yard at various depths as mentioned in methodology.

4.1 Composition of solid waste as per examination of samples

Sampling Details:

- Methodology of Sampling: Manual Sampling
- Quantity of sampling: 10 Numbers of samples
- Device used: Designed sampler, weighing machine
- Weight of each sample: 1000 grams

Analysis procedure:

- These samples are collected in polythene bags & transported to the laboratory for further analysis.
- In laboratory sorting of material, cleaning of contamination and air dried is performed. Durable items such as glass or plastic container can be washed prior to air drying and filled containers can be emptied of their contents.
- Further in the process waste is classified in 12 categories and then separating all materials as per categories & weight is measured of each category and recorded the same.

The composition of solid waste is the first step to understand the solid waste. To better understand the characteristics, composition is analysed at various depths as specified in methodology.

In depth up to 2 feet the primary finding of the sampling is that more than 40 % waste is organic in nature, the food scrap consists about 30 % and the yard trim is about 11%. This high potential of biodegradable waste shows the potential for composting. The food scrap composition decreases drastically when the depth increases and reaches to the negligible at the depth of 6 feet.

The recyclable composition (include rubber, plastic, metals, glass, paper, etc.) consist more than 30 % at every depth which shows the need of segregation at source. Among the recyclable plastic waste contributes the highest as compared with other recyclable waste.

As per the examination of samples it has been observed that the dust has been increased drastically with respect to the depth which has been observed highest i.e. 37 % in the depth range (4 to 6) feet.

The observation shows that the composition changes significantly within the dumping yard from place to place as well as with depth. If the service level of segregation at source is increased from the current level it will definitely create an opportunity of composting as well as recycling waste and directly reduce the load on solid waste dumping yard. The detail readings of sample at Phursungi dumping yard are shown in pie chart.

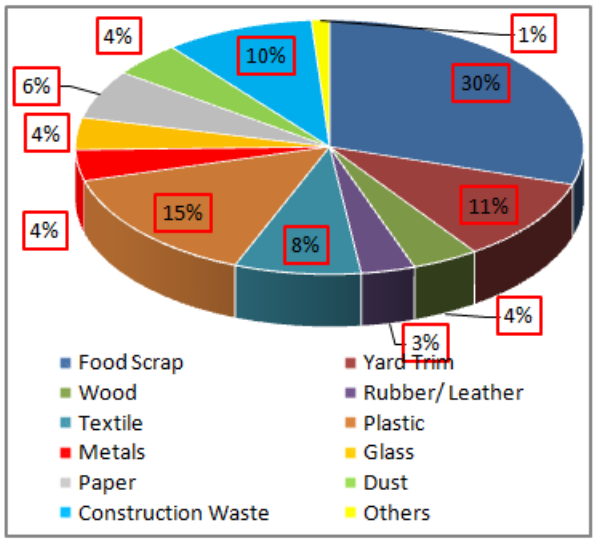

Figure 2: Chart showing waste constituents at depth (0-2) feet.

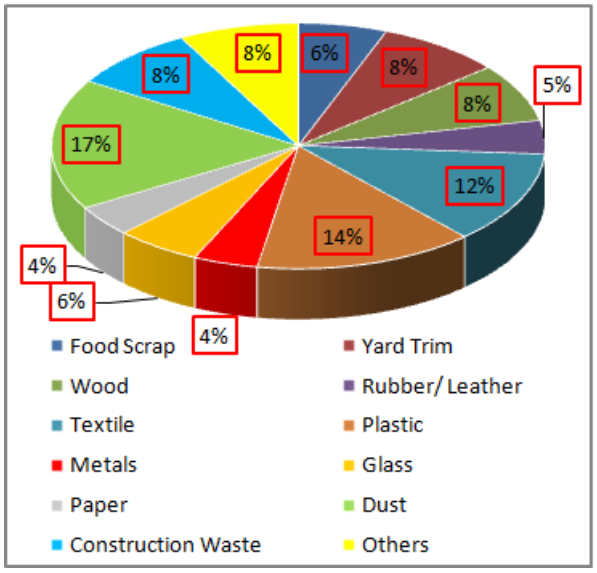

Figure 3: Chart showing waste constituents at depth (2-4) feet.

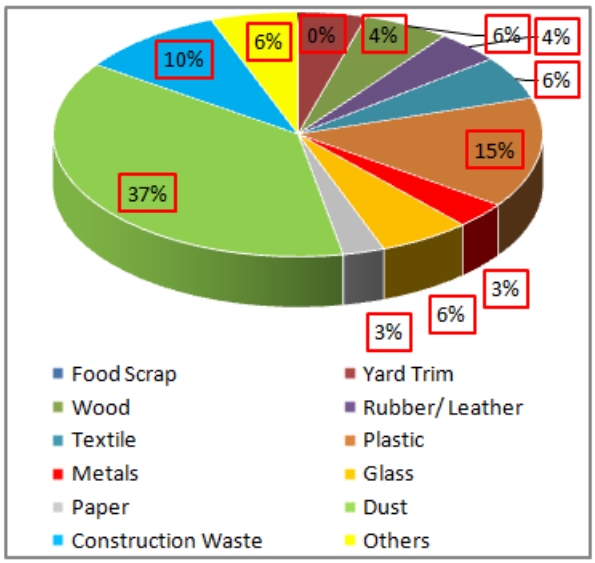

Figure 4: Chart showing waste constituents at depth (4-6) feet.

4.2 Moisture content of solid waste as per examination of samples

Sampling Details

- Methodology: Random manual sampling with designed sampler.
- Quantity of sample: Minimum 3 samples or number required to get essential amount of material (100 grams) of each constituent.
- Device used: Designed sampler, weighing machine, oven, dedicator.

Analysis procedure:

- Weigh the aluminium dish
- Fill the dish with solid waste sample& weight the same.
- Dry solid waste and dish in an oven for at least 24 hours at 77 degree Celsius
- Remove the dish from oven and allow it for cool in a dedicator.
- Record the weight of dry solid waste + dish.
- Calculate the moisture content (M) using following equation.

$$M = \frac{(W - D) \times 100}{W}$$

W------ Wet weight
D ------ Dry weight

At depth (0-2) feet the primary verdict of the sampling is that food scrap consist the highest moisture content more than 25% and the yard trim consist about 6%, this biodegradable waste responsible for high percentage of moisture content in solid waste and making the solid waste difficult for incineration process as it requires more fuel and energy to evaporate the moisture and this high moisture content of biodegradable waste show the need and necessity for composting of biodegradable waste. The moisture content of food scrap and yard trim is decreasing considerably with depth. When depth is increasing from (2-4) feet to depth (4-6) feet the moisture content is negligible which shows the swift decomposition of food scrap.

The moisture content of composition include (rubber, leather, plastic, paper, glass, textile, paper) decreases with increase in the depth. Among recyclable waste textile has the highest moisture content. The moisture content of solid waste of recyclable composition shows the great need of segregation at source which will decrease the load on dumping yard.

The overall observation shows that moisture content of solid waste is varying a lot within the dumping yard from place to place and even with the depth.

If the service level of recovering municipal solid waste is increased from current level then there will be more opportunities for incineration and composting. The

moisture content of various constituents of solid waste at Phursungi dumping yard are shown in graphical form.

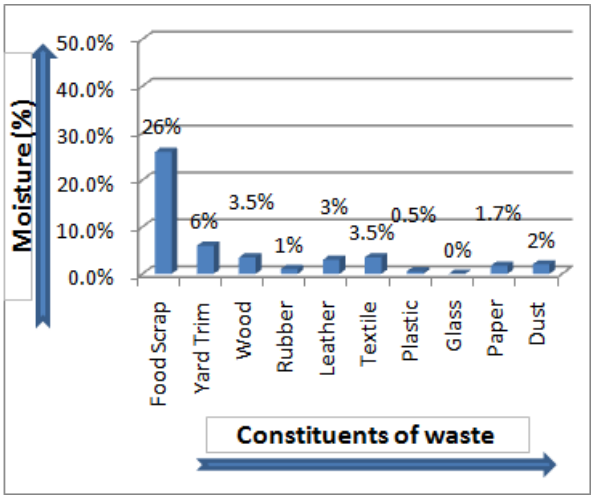

Figure 5: Chart showing waste constituents at depth (0-2) feet**.**

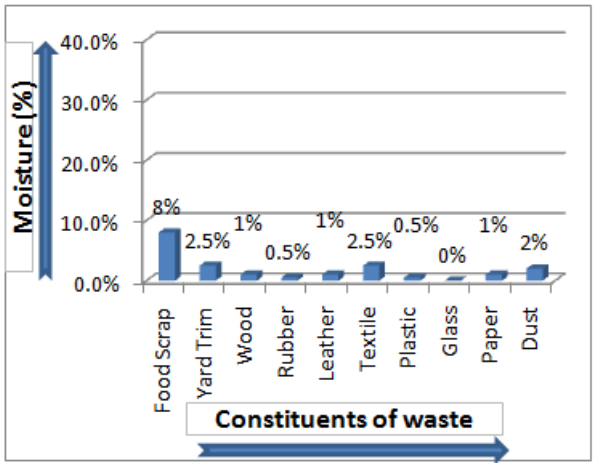

Figure 6: Chart showing waste constituents at depth (2-4) feet**.**

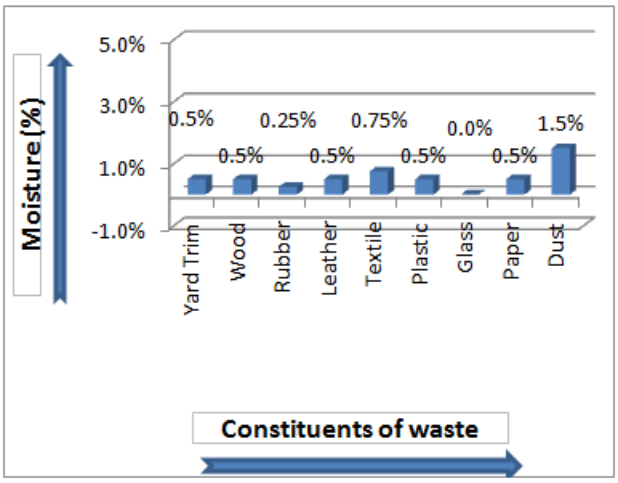

Figure 7: Chart showing waste constituents at depth (4-6) feet**.**

4.3 Undisturbed Density of Solid waste as per examination of samples

Sampling Details

- Methodology: Random manual sampling with designed sampler.
- Device used: Designed sampler, weighing machine.
- Number of samples: 10 Numbers

Analysis procedure:

- The weight of collected samples of solid waste is measured and noted down.
- The volume of sample can be measured by the formula for volume of cylinder $\frac{\pi d^2}{4} \times h$
- Where'd' is diameter of designed sampler and 'h' is height of sample. In our case d = 3 inch i.e. 0.076 m & h = 2 feet i.e. 0.609 m.
- The undisturbed bulk density can be calculated by using the below formula

$$\text{Undisturbed Density} = \frac{\text{Mass of undisturbed solid waste (in sampler device)}}{\text{Volume of sampler } (\frac{\pi d^2}{4} \times h)}$$

The primary outcome of examination of sampling is the undisturbed density is increasing with the increase in depth. At depth of 0-2 feet density varies 343Kg/m^3 to 458 Kg/m^3 which give the average density of sample about 382 Kg/m^3. At depth of 2-4 feet density varies 380Kg/m^3 to 489 Kg/m^3 which give the average density of sample about 421 Kg/m^3. At depth of 4-6 feet density varies 360Kg/m^3 to 489 Kg/m^3 which give the average density of sample about 457 Kg/m^3. The observations shows that the value of each samples are varying in horizontal plane as well as vertical plane which indicate anisotropic nature of solid waste at Phursungi dumping yard.

The detail reading of moisture content of various constituents in solid waste are represented in graphical.

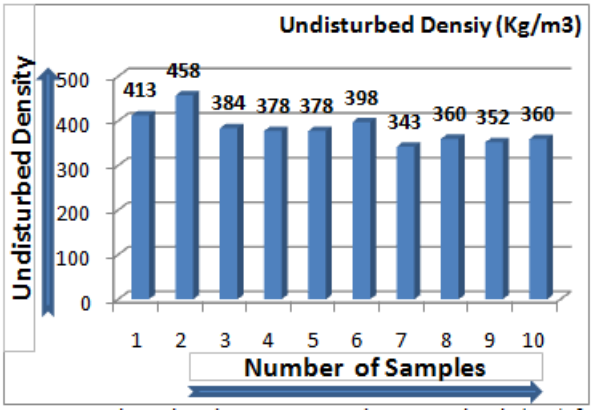

Figure 8: Chart showing waste constituents at depth (0-2) feet**.**

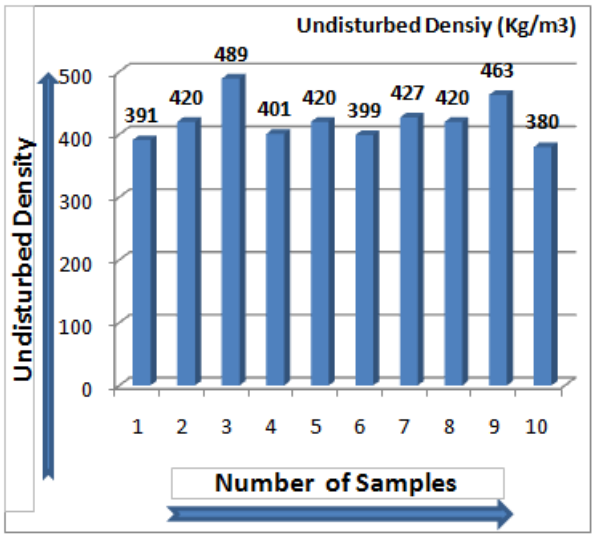

Figure 9: Chart showing waste constituents at depth (2-4) feet**.**

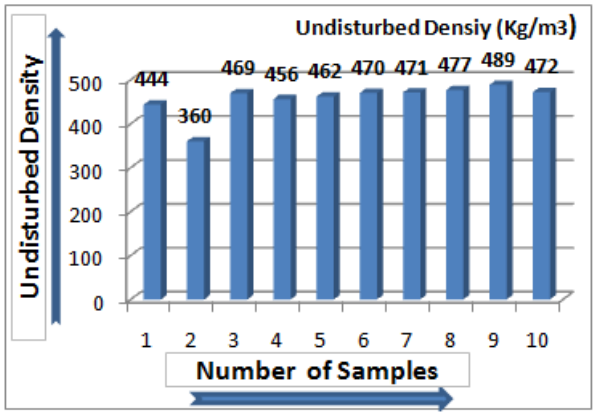

Figure 10: Chart showing waste constituents at depth (4-6) feet

4.4 Temperature of Solid waste as per examination of samples

Sampling Details

- Methodology: Random manual sampling with designed sampler and measuring the temperature of the same.
- Device used: Designed sampler, thermometer.
- Number of samples: 10 Numbers

Analysis procedure:

The temperature of collected samples of solid waste is measured with the help of thermometer and noted down.
The primary outcome of study of sampling is the temperature is slightly decreased with increase in depth. There is a difference of 1 °C while going to the depth up to 6 feet. At depth of 0-2 feet the temperature varies from 36.8 °C to 37.2 °C which gives the average temperature about 37 °C, the maximum temperature difference in the reading of sample is 0.40 °C. At depth of 2-4 feet the temperature varies from 36.4 °C to 36.6 °C which gives the average temperature about 36.52 °C, the maximum temperature difference in the reading of sample is 0.20 °C. At depth of 4-6 feet the temperature varies from 35.8 °C to 36.2 °C which gives the average temperature about 36 °C, the maximum temperature difference in the reading of sample is 0.40 °C

The temperature of various samples of solid waste at Phursungi dumping yard at various depth levels are represented in graphical form below for appropriately understanding of variation of temperature in horizontal plane as well as with depth.

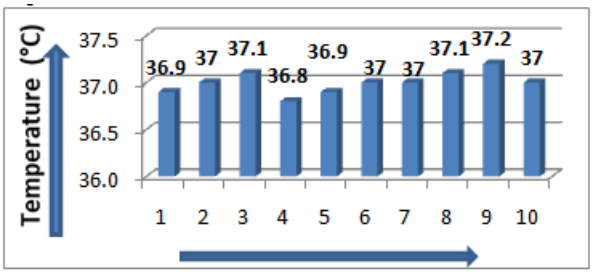

Figure 11: Chart showing waste constituents at depth (0-2) feet**.**

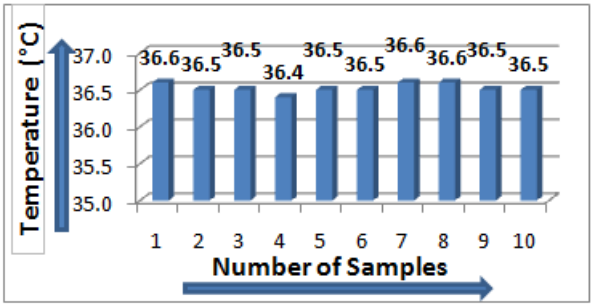

Figure 12: Chart showing waste constituents at depth (2-4) feet**.**

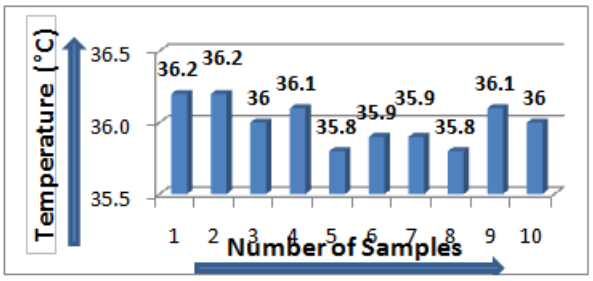

Figure 13: Chart showing waste constituents at depth (4-6) feet

5. Conclusion

For appropriate solid waste management the understanding of characteristics of solid waste plays very important role as there is no 'one size fits all' and there is always a scope for improvement and learning. The waste generated from the city has particular character; the waste from the city is besides organic one but it has contained some amount of recyclable inorganic part also. As per the keen examination of all samples, it has been observed that the values of composition are different in all the randomly selected places. Even though the change in the content of solid waste with respect to various depths gives a diverse value. The observation regarding moisture content can be clearly seen is decreasing with respect to depth. On the other hand the bulk density of solid waste is increasing with respect to depth. The temperature at the depth of 6

feet as compared to top surface (exposed surface) is less by 1 °C. It can be clearly seen that the variation in horizontal as well as vertical plane readings represent the anisotropy of municipal solid waste need to treat as highly anisotropic material.

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