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INVESTIGATIVE STUDY OF MUNICIPAL SOLID WASTE ANISOTROPY AT PHURSUNGI DUMPING YARD IN PUNE REGION, MAHARASHTRA, INDIA

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Abstract-The municipal solid waste (MSW) of Indian city has a low calorific value with high moisture content and quantity of non-combustibles which make it not suitable for incineration, and currently none of the municipal corporations in India runs a full-scale incineration plant. In India about 77% of solid waste has been disposed by Land dumping only and the efficiency of the method will depend upon our understanding of the geotechnical properties of MSW. The properties of MSW vary not only with space, but also with respect to time. The recent studies indicate that MSW is highly anisotropic. In this paper the analytical study of municipal solid waste anisotropy with respect to shear resistance and shear strength has been examined.

Keywords – Municipal solid waste Anisotropy, Phursungi dumping yard, Shear resistance, shear strength.

I. INTRODUCTION

The issues of municipal solid waste management (MSW) have already attained frightening magnitudes in India. Continuously increase in population, urbanization, industrialization and change in the lifestyle of people result into the complication in managing solid wastes. On the other hand government is also planning for smart cities across the country which is if not managed or planned properly is going to worsen the situation of municipal solid waste management in India.

According to a latest CPCB report, in 2016, India produced some 52 million tons of waste each year of which roughly 23 per cent is processed or disposed using appropriate technologies. Approximately 77 per cent of solid waste is simply discarded to dumping yard with minor treatment or no treatment. But the major concern, which most of the methodology do not take into consideration is anisotropy. Anisotropy is one of the important characteristic which should be considered for solid waste disposal method. [1]

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. The city generates about 1500 to 1700 MT of waste per day, which is noteworthy amount and it is going to rise with the population in the forthcoming years so it is prerequisite of time for ground-breaking way of municipal solid waste disposal practice. For that, it is significant to know the anisotropy and its application in engineering practice of solid waste management. In this paper the study of municipal solid waste characteristic and anisotropy of Phursungi dumping yard has been deliberate which is regulated up to 6 feet depth. [2][3]

II. LITERATURE REVIEW

A) Literature Review on MSW Anisotropy and Phursungi Dumping Yard

Sr. No.	Paper	Author	Year of Publication	Remarks

1.	Experimental evidence of anisotropy in municipal solid waste [4]	D. Zekkos	2013	1) Experimental analysis indicates that Municipal Solid Waste (MSW) is a highly anisotropic material. Both *fabric (and structural) and stress-induced anisotropy* are identified. 2) The shear resistance of MSW is found to be significantly affected by the orientation and type of fibrous waste constituents. 3) Hydraulic conductivity of MSW in the horizontal direction is also significantly higher than the hydraulic conductivity in the vertical direction.
2.	Municipal solid waste effective stress analysis [5]	Nader Shariatmadari, Sandro Machado, et al.	2009	1) In this paper results are acquired from 26 large scale tri-axial tests performed under drained and un-drained conditions demonstrated that materials present a high level of deformation anisotropy under isotropic consolidation. 2) Analyses of the MSW volume change showed that the waste particles are highly compressible and this restricts the contribution of the pore water pressure on the effective stress level.
3.	Analytical study of Hydraulic Conductivity of Municipal Solid Waste of Phursungi Dumping Yard by Falling Head Method [6]	Chetan G. More, et al.	2017	1) In this paper, with the help of custom built setup and using falling head method, hydraulic conductivity of samples from Phursungi dumping yard has been analysed which is in the range of 4.7 x 10^{-4} to 5.1x 10^{-4} cm/s. 2) It has been observed that the hydraulic conductivity is decreasing with the increase in depth due to the change in density.
4.	Review of Anisotropy & Its Applications for Municipal Solid Waste [7]	Chetan G. More	2017	1) The influence of waste anisotropy on engineering practice remains unknown, but anisotropy is expected to play a role in many aspects of landfill engineering practice. 2) Currently, engineering practices do not consider the influence of anisotropy on the design and performance of MSW landfills which will definitely optimize the efficiency of Solid Waste Management.

B) Literature review on Shear resistance value

Tittle of Research Paper	Year of Publish	Strain at Strength (%)	Cohesion (kPa)	Friction angle (°)
Geotechnical properties of fresh municipal solid waste in Orchard Hills Landfill by Reddy et all[8]	2009	15	46 64 32 31	30 26 28 30
Geomechanical properties of municipal solid waste in Dona Juana sanitary landfill by Caicedo et all [9]	2002	15	78	22
Compressibility and shear strength of municipal solid waste under short-term leachate	2009	15	12 63	31

recirculation operations by Krishna R. Reddy et all [10]			34 56	35 32

III. MATERIAL AND METHODOLOGY

The research work includes the efforts for examination of samples at various depths (0-2), (2–4) and (4–6) feet with the help of specially designed cylindrical sampler and accumulating the data for conclusive elucidation. The learning of municipal solid waste anisotropy has been evaluated on the aspects of shear resistance.

The value of shear strength for municipal solid waste play vital role in the study of municipal solid waste anisotropy along with also requisite in the design of engineering problems such as foundation, retaining walls, bridges, sheet pilling, etc.

Considering a particular zone (northern side of dumping yard) as shown in fig. 1 from where samples are collected for analysis. The samples were collected from various depths with the designed sampler as stated in methodology.

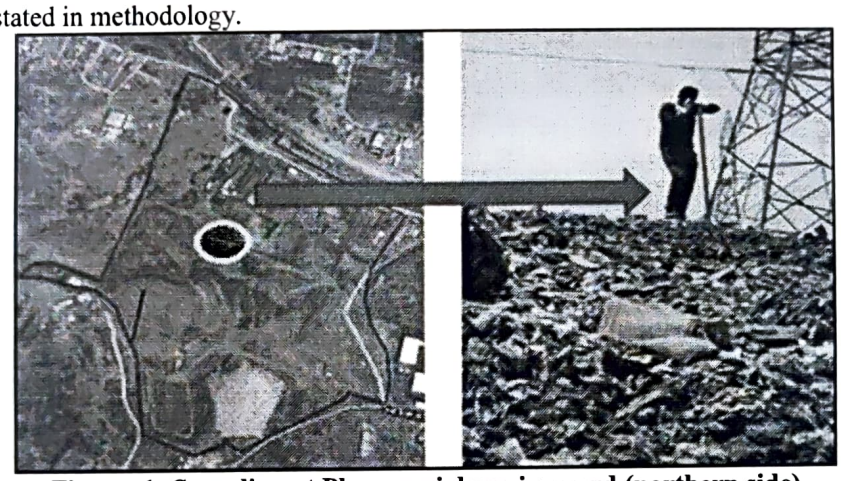

Figure. 1: Sampling at Phursungi dumping yard (northern side)

IV. EXPERIMENTAL SETUP

Direct shear test were performed in accordance with IS 2720 in a square box 60 mm x 60 mm size and 25 mm height. The initial density of samples are 382, 421 and 457 kg/m^3 for the depth (0 – 2), (2 – 4) and (4 – 6) feet respectively. The samples were sheared at a constant strain rate under normal stress condition of 150 Kpa, 200 Kpa and 250 Kpa. The experimental set up for direct shear device consist of following as shown in fig. 2

1. Direct shear box apparatus, and Loading frame (motor attached)
2. Dial gauge for vertical deformation measurement
3. Dial gauge for horizontal deformation measurement
4. Proving ring for Shear force measurement and loads are kept in loading frame for application of Normal stress.
5. Components of shear box with pair of grid plate, metal plate, filter paper etc.

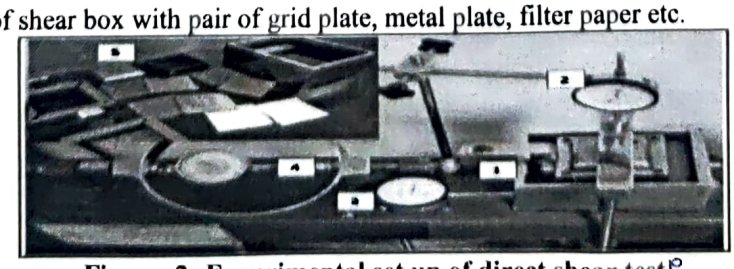

Figure. 2: Experimental set up of direct shear test

V. RESULT AND DISCUSSION

❖ **Shear Resistance**

The analysis of shear resistance by direct shear test is shown in graphical representation in below section at various depths as stated in methodology.

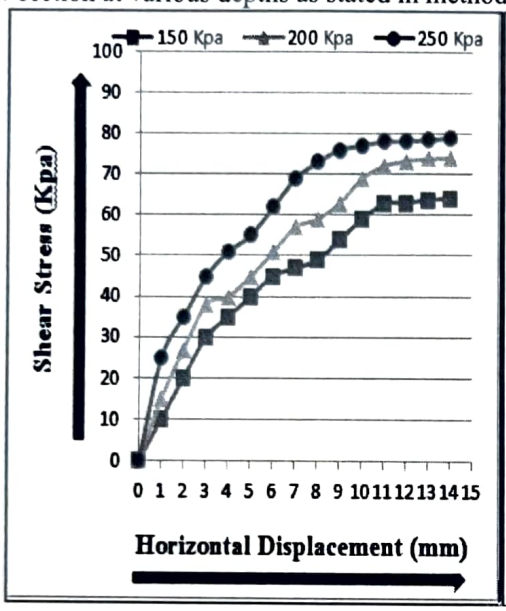

Figure 3: Shear Stress v/s horizontal displacement curve for the samples (0 -2) feet

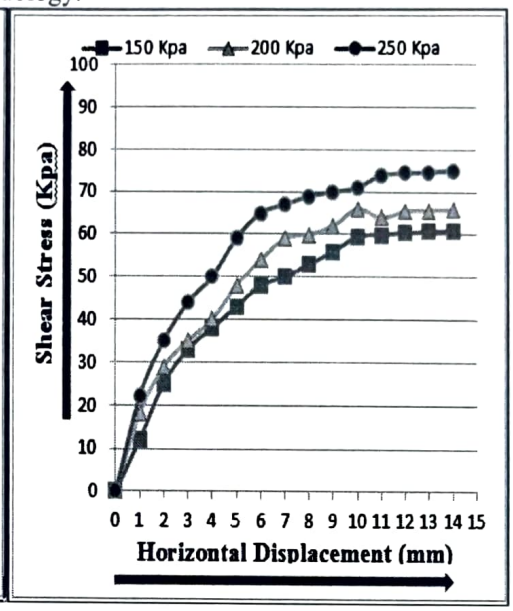

Figure 4: Shear Stress v/s horizontal displacement curve for the samples (2 -4) feet

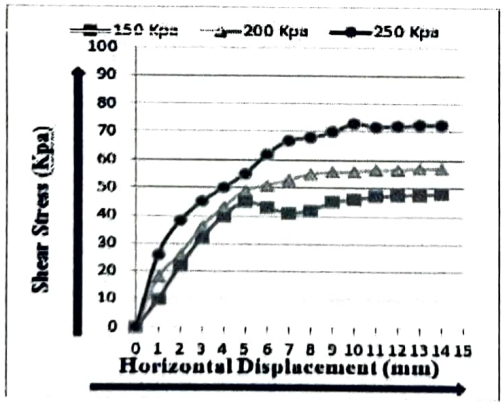

Figure 5: Shear Stress v/s horizontal displacement curve for the samples (4 -6) feet

As it can be perceived from the graphs that similar trends were observed for sample specimen of various depths. During these study municipal solid waste shows continues strength gain at horizontal deformation

During this study strength was defined at 15% horizontal deformation so that the results can be compared to the values of other research works.

❖ **Shear Strength**

The value of cohesion and friction angle of landfilled municipal solid waste are represented in the form of graphical presentation in below section.

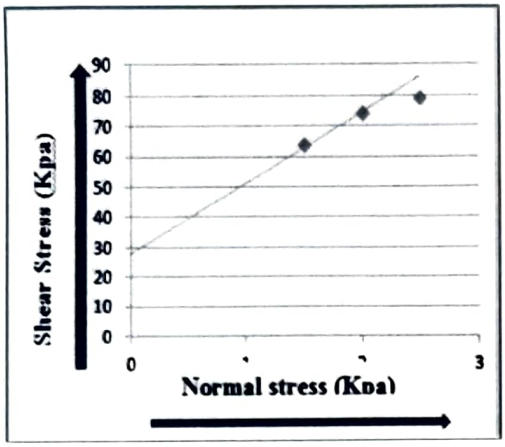

Figure 6: Shear stress v/s normal stress for the samples (0 -2) feet

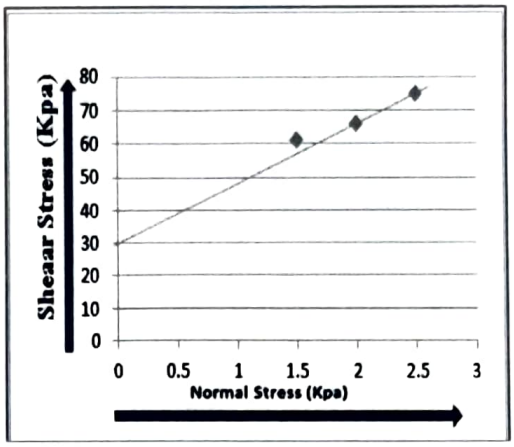

Figure 7: Shear stress v/s normal stress for the samples (2 -4) feet

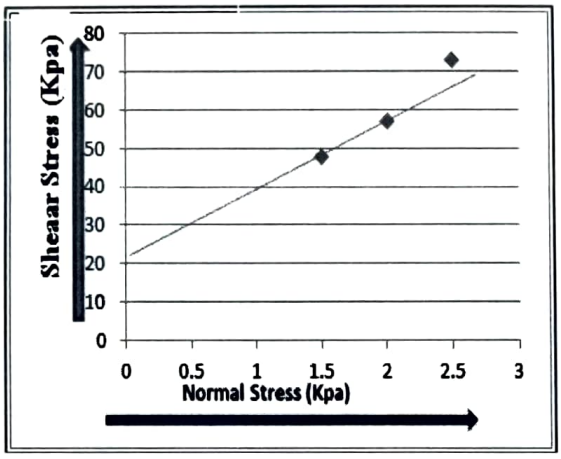

Figure 8: Shear stress v/s normal stress for the samples (4 -6) feet

It has been observed from literature review that the cohesion of landfilled municipal solid waste varied from 12Kpa to 64Kpa and friction angle ranged from 23° to 35°. In this study both cohesion and friction angle did not show any specific increase or decrease in this study for the specified depth.

VI. CONCLUSION

It has been observed from direct shear test that the shear resistance values of landfill municipal solid waste showed continues strength gain at horizontal deformation and the value of cohesion and friction angle of landfilled waste is varied from 22Kpa to 30Kpa and 29° to 31° respectively. Both cohesion and friction angle did not show any specific increase or decrease for the range of depth tested in this study.

It can be evidently seen that the variation in horizontal as well as vertical plane readings in characteristics of solid waste, shear resistance represent the municipal solid waste are highly anisotropic in nature and need to treat as highly anisotropic material and carefully considered while design, operation and treatment process of municipal solid waste.

As there is no 'one size fits all' and there is always a scope for improvement and learning, which gives the scope for advance study of municipal solid waste anisotropy on a larger scale at Phursungi dumping yard, with addition of cement, soil etc. to observe the strength gain is the future scope of study.

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